Response Action Contract IX

FIVE-YEAR REVIEW REPORT

FOR
PHOENIX-GOODYEAR AIRPORT (SOUTH)
SUPERFUND SITE
GOODYEAR, ARIZONA

September 2005

U.S. Environmental Protection Agency
Contract No. 68-W-98-225

CH2M HILL, Inc.
and Team Subcontractors:
URS Greiner Woodward Clyde Federal Services, Inc.
E2 Consulting Engineers, Inc.

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Prepared for
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United States Environmental Protection Agency
Region 9
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Approved by: Date:

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List of Acronyms

ARARs	Applicable or Relevant and Appropriate Requirements
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	constituents of concern
DCE	dichloroethene
Eco-SSL	ecological screening level
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
GAC	granular activated carbon
gpm	gallons per minute
GTRC	Goodyear Tire and Rubber Company
MCL	maximum contaminant level
μg/L	micrograms per liter
mg/L	milligrams per liter
NPL	National Priority List
O&M	operation and maintenance
OU	Operable Unit
PCE	perchloroethylene (tetrachloroethene)
PGAN	Phoenix-Goodyear Airport-North Superfund Site
PGAS	Phoenix-Goodyear Airport-South Superfund Site
ppbv	Parts per billion by volume
PRP	potentially responsible party
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation/feasibility study
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act

SDWA	Safe Drinking Water Act
TCE	trichloroethene
VOC	volatile organic compound

Five-year Review Summary Form

SITE IDENTIFICATION
Site name : Phoenix-Goodyear Airport (North) Superfund Site
EPA ID: AZD980695902 **CERCLIS ID :** AZD980695902
Region: IX **State:** AZ **City/County:** Goodyear/Maricopa
SITE STATUS
NPL status: ■ Final ❑ Deleted ❑ Other (specify) __________
Remediation status (choose all that apply): ■ Operating ❑ Complete
Multiple OUs? ■ YES ❑ NO **Construction completion date:** N/A Subunit A-Section 16 groundwater OU (OU 2), Subunit B/C groundwater OU (OU 6), and Soils OU (OU 1)
Has site been put into reuse? ■ YES ❑ NO
REVIEW STATUS
Reviewing agency: ■ EPA ❑ State ❑ Tribe ❑ Other Federal Agency __________
Author name: Mary Aycock
Author title: Remedial Project Manager **Author affiliation:** EPA Region IX
Review period: March – September 2005
Date(s) of site inspection: April 28, 2005
Type of review: ■ Statutory ❑ Policy ❑ Post-SARA ❑ Pre-SARA ❑ NPL-Removal only ❑ Non-NPL Remedial Action Site ❑ NPL State/Tribe-lead ❑ Regional Discretion)

Review number: ■ 1 (first) ❑ 2 (second) ❑ 3 (third) ❑ Other (specify)

Triggering action:

❑ Actual RA Onsite Construction at OU

■ Actual RA

❑ Previous Five-year Review Report

❑ Construction Completion

❑ Other (specify) ______________________________

Triggering action date: 1990 (Start of Subunit A/Section 16 OU groundwater treatment)

Due date (five years after triggering action date): 1995. This five-year review was conducted in 2005; it is *overdue* from the triggering action date.

Issues and Recommendations:

1. Issue
There is a lack of recent data on trace metals other than chromium in groundwater. Metals such as cadmium, lead, arsenic and nickel were identified in the 1989 RI/FS and 1989 ROD as contaminants exceeding ARARs. However, there has been little monitoring for these metals, based on documents obtained as part of the five-year review. It is possible that if these metals are determined to be present in Subunit A, the current remedy will reduce concentrations through redistribution, as is the case with chromium. Compounds listed in Table 3-12 of the 1989 RI/FS that exceeded current MCLs include antimony, arsenic, cadmium, chromium and lead.

Recommendation
Evaluate historical distribution of trace metals and develop a plan to sample any locations that potentially contain trace metals at levels higher than current ARARs.

2. Issue
There has been no confirmation monitoring in the vicinity of the former sludge drying beds. Although geotechnical and chemical tests were performed during the soil stabilization process, there is no post-remedy monitoring data to ensure that the remedy was effective.

Recommendation
Obtain samples from Subunit A groundwater monitor wells in the vicinity of the former sludge drying beds to confirm that there has been no impact to groundwater.

3. Issue
Prior remediation for chromium and cadmium may not be adequately protective of ecological receptors, as there are areas of soil with concentrations of metals above ecological risk levels, but below the human-health-based levels set forth in the 1991 Action Memorandum, which were not excavated as part of the remedial actions. Areas of particular concern include the former chrome sludge drying beds, the airport drainage ditch near Outfall 1, the former sewage treatment plant, former paint tent area and the hangar apron area.

Recommendation
Conduct a screening-level Ecological Risk Assessment to determine whether additional characterization or risk analysis is necessary.

4. Issue
There has been no assessment of vapor intrusion. There may be areas near buildings that contain residual TCE at levels sufficient to pose a threat to indoor air quality.

Recommendation
Assess concentrations of TCE and other VOCs in shallow soil gas to evaluate potential impact on indoor air quality.

5. Issue
Capture of the northern Subunit B/C plume has not been thoroughly demonstrated. Current understanding of the extent of TCE contamination in the vicinity of E-102, particularly along the northern and western margins, is not confirmed with sentinel wells. E-102 is at the distal end of the northern Subunit C plume, with a TCE concentration of 4.9 µg/L in the second half of 2004 (Sharp and Associates, 2005b). Cessation of injection at injection wells and off-site pumping may impact future plume movement.

Recommendations
1. Evaluate aquifer hydraulic data and contaminant trends to confirm capture of the northern Subunit B/C plume.
2. Expand the monitoring program to extend north and west of the currently delineated plume. Additional monitoring well(s)/sentinel well(s) may be required if there are not already appropriate monitoring points.

6. Issue
Vertical capture of the northern and southern Subunit B/C plumes has not been demonstrated.

Recommendation

Evaluate vertical capture of the Subunit B/C plumes through the use of aquifer data, gradient calculations, possible installation of monitoring wells and other appropriate means.

7. Issue
Chromium in Subunit A groundwater is not currently being treated as required by ESD #3. Although the chromium treatment system was shut down in 2001 and approved for removal in 2003 based on treatment plant effluent concentrations, this may need to be reevaluated, as TCE removal cannot be optimized without chromium treatment. One alternative that was evaluated in 1995 was the Lewis carbon system. Although this was more expensive to operate for the short term, it may be less problematic than the affinity chromatograph that was used previously at the site. Also, additional technologies may have been developed since 1995.

Recommendation
1. Evaluate installation of one or more chromium treatment systems for wells that show high concentrations of this metal.
2. If treatment is found to be unnecessary, an Explanation of Significant Difference should be issued to formalize this change from the remedy specified in ESD #3.

8. Issue
Removal of TCE from Subunit A cannot be optimized due to chromium concentrations above the cleanup level.

Recommendation
Optimize the pumping regime for removal of the TCE mass, which may require chromium treatment and/or some other technical approach.

9. Issue
The Western Avenue PCE plume has encroached upon the Subunit A TCE plume at the site. Concentrations of PCE are currently below the MCL in groundwater monitoring wells, and it is believed that

all contamination migrating onto the PGAS site has been captured by the Subunit A treatment system.

Recommendation
Continue monitoring movement of the Western Avenue PCE plume.

10. Issue
Perchlorate from the PGA North site has been detected in nearby production wells. Although perchlorate is not a contaminant of concern at PGAS, its movement may impact groundwater at PGAS, particularly north of Yuma Road.

Recommendation
Continue monitoring movement of perchlorate from the PGA North site.

11. Issue
There have been several incidents of unexpected maintenance costs at the site, arising from a leak in the acid tank at the Subunit A treatment facility, a leak in a raw water line for a Subunit A extraction well, and disruption of electrical services in unprotected buried electric lines. In addition, observations were made during the site inspection of rusting wellhead piping, missing locks on well vaults and missing caps on discharge pipes and sounding tubes, that may lead to additional maintenance costs in the future. Most of these issues are due to the aging of the components of the treatment system. Also, the Operation and Maintenance Plan has not been updated since 1994.

Recommendations
1. Conduct preventative maintenance to reduce unexpected costs and maintain long-term viability of the treatment systems.

2. Update the Operation and Maintenance Plans for the site.

12. Issue
Current institutional controls may not prevent exposure to contaminated media in the future, particularly as properties change hands. There are no institutional controls currently in place for contaminated soil, including the former sludge drying beds, or for groundwater contamination that has migrated beyond the property boundaries.

Recommendation
Implement additional institutional controls to ensure continued prevention of exposure to contaminated media.

Protectiveness Statement:

The remedies at PGAS for groundwater and soil (OUs 1, 2 and 6) are currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled. In order for the remedy to remain protective in the long term, institutional controls may need to be put into place at the site.

The next five-year review for PGAS will be conducted on or before September 2010.

1.0 Introduction

The United States Environmental Protection Agency (EPA) conducted a five-year review of the remedial actions implemented at the Phoenix-Goodyear Airport South (PGAS) Superfund Site, in the City of Goodyear, Maricopa County, Arizona (Figure 1-1). This review, conducted from March to September 2005, is the first five-year review for PGAS. CH2M HILL assisted with the preparation of this review.

The PGA site was listed on the National Priorities List (NPL) in September 1983 as the Litchfield Airport Area Superfund Site. After the airport property was transferred to the City of Phoenix, the site was renamed the Phoenix-Goodyear Airport Area Superfund Site. Later, the site was divided into two parts: Phoenix-Goodyear Airport-North (PGAN) and Phoenix-Goodyear Airport-South (PGAS). The Potentially Responsible Parties (PRPs) for PGAN were identified as Unidynamics-Phoenix, Inc. and Crane Co. PGAN is not evaluated as part of this five-year review report. The three PRPs for PGAS are Goodyear Aerospace Corporation (now The Goodyear Tire and Rubber Company [GTRC]), Loral Corporation, and the Litchfield Airport Naval Air Facility. The southern portion of the PGA site (PGAS) is the subject of this five-year review.

The five-year review process evaluates whether a selected remedy remains protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports. In addition, five-year review reports identify any deficiencies found during the review and provide recommendations for addressing these deficiencies.

This review is required by federal statute. EPA must implement five-year reviews consistent with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). CERCLA Section 121(c), as amended, states:

> If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented.

This five-year review is a statutory review because hazardous substances, pollutants, or contaminants remain at PGAS above levels that allow for unrestricted use and unlimited exposure during soil remediation activities and ongoing groundwater remediation activities, and because the ROD was signed after October 17, 1986, the effective date of the Superfund Amendment and Reauthorization Act (SARA).

The central issue at the PGAS site is contamination of groundwater with volatile organic compounds (VOCs), particularly trichloroethene (TCE), and chromium. The PGAS site currently includes two groundwater operable units (OU) and one soil OU. The groundwater OUs are OU 2 (also known as the Section 16 OU), which is for shallow groundwater (Subunit A), and OU 6 (also known as the Subunit B/C OU). These two OUs are currently undergoing remedial activities that started in 1990 (Subunit A) and 1994

(Subunit B/C). The soil OU (OU 1), which contained VOCs and chromium, has been remediated at PGAS and no further monitoring activities are being conducted. A separate area of contamination resulted from a leaking underground storage tank (UST) owned by the City of Phoenix. Actions taken to address this leak of aviation fuel is described but not evaluated in this five-year review because the aviation fuel constituents are not COCs addressed in the remedy.

This is the first five-year review report for PGAS. The triggering action for the five-year review report is the groundwater remedial action start date of 1990. This report evaluates the PGAS remedial action objectives as stated in both Records of Decision (RODs), Explanation of Significant Differences (ESD) #1, #2, #3, and #4, and the 1991 Action Memorandum.

This report covers all three OUs. It is organized into sections that describe the history and setting of PGAS, remedial action decisions and implementation, and an evaluation of remedial actions. These sections are:

- Section 2.0: Chronology of PGAS events.
- Section 3.0: Land use, PGAS setting, the history of contamination, and initial response.
- Section 4.0: The remedial action implemented at PGAS, current status of the remedy, and treatment system operation and maintenance (O&M) activities and cost.
- Section 5.0: Activities performed during the five-year review process.
- Section 6.0: Technical assessment of the remedial action implemented at PGAS.
- Section 7.0: Issues at PGAS are identified and recommendations provided.
- Section 8.0: Protectiveness statement for PGAS.
- Section 9.0: Next five-year review.
- Section 10.0: List of works cited during the preparation of this document.

2.0 Site Chronology

Table 2-1 provides a chronology of events at PGAS.

TABLE 2-1
Chronology of PGAS Events
Phoenix-Goodyear Airport (South) Superfund Site
City of Goodyear, Maricopa County, Arizona

Event	Date
Goodyear Aerospace Corporation (later Goodyear Aircraft Corporation and the Goodyear Tire and Rubber Company [GTRC]), Arizona Division, began operations	1942
The United States Navy established the Litchfield Naval Air Facility in Goodyear, Arizona as an Auxiliary Acceptance Unit	1943
Oily and chrome-colored contamination detected in drainage ditch on airport	1951
Wastewater treatment plant upgraded to reduce the emissions observed in 1951	1952
Ownership of the airport property transferred to the City of Phoenix	1968
Congress enacted Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	1980
The Arizona Department of Health Services discovered that groundwater in the PGA area was contaminated with solvents and chromium	1981
PGA Site (combined) listed on the National Priority List as Litchfield Airport Area Superfund Site	1983
Remedial Investigation at PGA site begun by EPA	1984
Evaluation of Soils and Shallow Groundwater Contamination (1991 CO)	1985
Congress passed Superfund Amendments and Reauthorization Act (SARA) and added $8.5 billion to the Superfund (CERCLA) program	1986
Record of Decision (ROD) issued for Subunit A groundwater (Section 16 OU) at PGAS	September 1987
Consent Decree with GTRC to begin treating contaminated groundwater in Subunit A	1988
Leaking Underground Storage Tank found to have leaked aviation gasoline at PGAS	1988
Record of Decision (ROD) issued for Subunit B/C groundwater and soil (except for the sludge drying beds)	September 1989
Groundwater extraction and treatment system for Subunit A groundwater implemented by GTRC	1990
Explanation of Significant Difference (ESD) #1 issued to revise cleanup levels for acetone and methyl ethyl ketone.	January 1991
Consent Decree with GTRC and Loral Defense Systems to: (1) construct a treatment system to hydraulically contain the contaminants in Subunits B and C and reduce the contaminant concentrations to meet the clean-up standards stated in the ROD; (2) to construct an SVE system to remove VOCs in the vadose zone; and (3) to continue operation of the Section 16 OU treatment system as set forth in the 1988 CD.	1991

TABLE 2-1
Chronology of PGAS Events
Phoenix-Goodyear Airport (South) Superfund Site
City of Goodyear, Maricopa County, Arizona

Event	Date
Action Memorandum issued for excavation, stabilization and monitoring of soil at former chromium sludge drying bed #2	October 1991
Consent Order with GTRC to excavate and stabilize soil at former sludge drying beds	January 1992
Conduit well investigation conducted	1992
Removal of sludge drying beds and stabilization of contaminated soil conducted	June 1992 through January 1993
ESD #2 issued to change the remedy for Subunit B/C from a centralized to a decentralized system; change the designated end use from municipal use to reinjection; add wellhead treatment to any domestic wells showing contamination from site contaminants; and establish treatment standards for benzene, ethylbenzene, 1,1,2,2-tetrachloroethane and tetrachloroethene	May 1993
Soil Vapor Extraction (SVE) implemented in Polygon 79.	September 1993 through January 1994
Northern Subunit B/C groundwater extraction and treatment system begins operation	February 1994
Southern Subunit B/C groundwater extraction and treatment system begins operation	September 1994
SVE implemented in Polygon 84	September 1994 through January 1995
Air sparging pilot test conducted for Subunit A groundwater	1995
Installation of chromium treatment system at Well E-17	1995
ESD #3 issued to allow air sparging in Subunit A groundwater; and to require the use of wellhead treatment for certain wells contaminated with chromium	December 1995
SVE implemented in Polygons 96, 27a and 92	March 1996 through April 1998
Air sparging implemented in Polygons 96, 27a, 92, 81 and 100	December 1996 through April 1998
ESD #4 issued to provide updated groundwater cleanup standards for toluene, barium, beryllium, cadmium, chromium, lead, nickel and selenium	March 1998
Chromium treatment system at E-17 shut down due to operational problems	2001
Air sparging in airport infield implemented for Subunit A groundwater	November 2001 through January 2003
New Northern Subunit C extraction well E-102 installed north of Yuma Road and connected to treatment system	2004

3.0 Site Background

The Phoenix-Goodyear Airport - South (PGAS) Superfund Site (the "Site") is defined by an area of VOC- and chromium-contaminated groundwater and soil that encompasses approximately 1 square mile beneath the Phoenix-Goodyear Airport and surrounding areas. The site is located 17 miles west of downtown Phoenix, Arizona. The remedy for PGAS is being conducted separately from the remedy at PGAN.

3.1 Land and Resource Use

Land use in the vicinity of PGAS is a mix of residential, agricultural, commercial, and industrial. The properties immediately adjacent to the airport are commercial, industrial, agricultural and residential. Commercial and industrial properties lie to the east of the airport, and agricultural land is to the north south and west. The nearest residences are approximately one-half mile west of the site and less the one-quarter mile northeast of the site, generally upgradient or cross-gradient of the contaminant plumes. Commercial and industrial buildings are located above portions of the Subunit A groundwater plume.

Groundwater is the primary source of water for all domestic, industrial and irrigation water in the area. Numerous production wells are located within one-half mile of the site. These wells are for municipal uses by the City of Goodyear as well as agricultural uses by various property owners. See Figure 3-1 for the locations of nearby production wells.

The treatment facility for Subunit A groundwater is located on the southern portion of the airport property. There are currently two treatment facilities for Subunit B/C groundwater; one is located on the western portion of the airport property, and one is located on commercial property immediately northeast of the airport property. There are 12 extraction wells for Subunit A and five extraction wells for Subunit B/C. Following treatment, the effluent is discharged to groundwater through 16 Subunit A injection wells and 5 Subunit C injection wells. The treatment system locations are shown on Figure 3-1.

In addition, there is one Subunit B/C production well, GAC #4, which was formerly used for groundwater treatment but is now a backup supply for Loral Corporation. This well is operated by Loral Corporation and when in use, water is treated by a reverse osmosis and granular activated carbon (GAC) treatment system.

3.2 Physical Setting

PGAS lies within the western Salt River Valley portion of the Basin and Range physiographic province, which generally consists of alluvial basins or plains separated by north- to northwest-trending mountain ranges (ADWR 1994). The Salt River Valley Basin is located in the Sonoran Desert. Regional climate is semi-arid and is characterized by long, hot summers and short, mild winters. Relative humidity is low, particularly during early summer. Rainfall averages about 7.5 inches per year. The average daily maximum temperature is 107 degrees Fahrenheit (°F) in July. The average daily minimum temperature is 36°F in January. The average annual temperature is 70°F.

Major surface drainages in the area are the Gila River, located two to three miles south of the site, and the Agua Fria River, located one to two miles east of the site. The Agua Fria River is dry most of the year, and flows south into the Gila River, where flow is largely dominated by effluent from the 91st Avenue Wastewater Treatment Plant. The western portion of the Salt River Valley is bordered on the south by the Estrella Mountains and to the west by the White Tank Mountains.

3.2.1 Geology/Hydrogeology

The western Salt River Valley alluvial sub-basin consists of thick basin-fill deposits of unconsolidated to semi-consolidated clastic sediments of the Late Tertiary to Quaternary age, alluvial fan, playa, and fluvial deposits. The alluvial deposits generally increase in thickness, and decrease in grain size toward the central areas of the sub-basin (ADWR, 1994). The basin-wide, alluvial deposits have been subdivided into three hydrogeologic units (ADWR, 1994). The alluvial deposits in the western Salt River Valley consist of, in descending order, the Upper Alluvial Unit (UAU), the Middle Alluvial Unit (MAU), and the Lower Alluvial Unit (LAU). The UAU is approximately 350 feet thick and is composed of three Subunits (A, B and C), which are described below. The MAU, made up of clay, silt, and mudstone with some interbedded sand and gravel, thickens towards the center of the basin (north of the PGAS site) and is up to 1600 feet thick. The LAU is comprised of conglomerate and gravel near the basin margins, grading to mudstone in the central areas of the basin. The thickness of the LAU increases towards the center of the basin, where it is several thousands of feet thick.

Contamination is currently confined to Subunits A, B and C of the UAU. An east-west hydrologic groundwater divide for Subunit A reportedly exists along Yuma Road, which divides the site into North and South portions (EPA 1989b). South of the divide, groundwater flow in Subunit A is generally to the southwest and west, while north of the divide groundwater flow is generally to the northwest and north. Currently, dynamic pumping regimes in the area may affect the presence or characteristics of the groundwater divide. There is generally a slight downward vertical hydraulic head gradient across the site.

Descriptions of the lithology at the PGA site were obtained from the 1989 RI/FS (EPA 1989b). Subunit A, composed of silty sand and gravel, is approximately 110 feet thick at PGAS. Depth to water is generally 70 to 80 feet below land surface (bls). The water in the UAU is generally of poor quality due to high salt and nitrate content.

Subunit B extends from approximately 110 to 160 feet bls and is composed of sandy silt with clay. This finer-grained unit appears to be continuous across the site and is considered to be an aquitard.

Subunit C extends from approximately 160 to 310 feet bls and is composed of silt, sand and gravel. Subunit C is used for agricultural, domestic and municipal water supply in the area. Subunits B and C are hydraulically connected.

The principal aquifers of the western Salt River Valley are the alluvial units described above. The UAU aquifer is generally hydraulically unconfined, while the MAU ranges from an unconfined to a semi-confined aquifer. The LAU aquifer ranges from a semi-confined to confined conditions, but may be unconfined in areas where the MAU is not present. Natural recharge to the basin-fill aquifer occurs as mountain front recharge, along perennial and ephemeral streams, and as agricultural and urban irrigation (ADWR, 1994).

3.3 History of Contamination

Contamination from the Site was observed as early as 1951, when a sample collected from the main airport drainage ditch was described as dark-colored, oily, with settlable solids and chromates present. The airport's wastewater treatment plant was upgraded in 1952 to address this contamination, but discharges of solvents into the drainage ditch likely continued after this time (EPA, 1989b).

In 1981, the Arizona Department of Health Services (ADHS) discovered that groundwater in the PGA area was contaminated with trichloroethene (TCE) (Ecology and Environment, 1983). Samples were collected in January, June and December 1981 from City of Goodyear (COG) wells (EPA, 1989b). Additional sampling of wells in 1982 and 1983 found 18 wells contaminated with TCE. As a result, the EPA added the overall PGA site to the National Priorities List (NPL) in September 1983 as the Litchfield Airport Area Superfund Site. In 1984, EPA began a remedial investigation of the Litchfield Airport Area (presently known as the Phoenix-Goodyear Airport) to characterize the site, discover the extent of contamination, and identify possible sources. Historical data indicate two primary contributors to contamination on the southern portion of the PGA site as the Goodyear Aerospace Corporation site, owned at that time by Loral Corporation, and activities carried out by the Navy at the Litchfield Park Naval Air Facility (EPA, 1987a).

Goodyear Aerospace Corporation (GAC, now GTRC) purchased the facility located at 101 South Litchfield Road in 1949 and operated on the airport property until 1968, and adjacent to (east of) the airport property until 1987. The facility adjacent to (east of) the airport remains in use by Loral Corporation. The plant was involved in the development and manufacture of aerospace related products including electronics equipment such as radar; transparent products such as aircraft and automobile windshields; and structural components such as MX missile transporter and aluminum-skinned shelters. Operations at the facility which have generated hazardous waste are primarily metal treatment processes such as plating, degreasing and etching. There was a chromate treatment plant for rinse water treatment in Building #1 in the 1970s (Ecology and Environment, 1983). The City of Phoenix continues to operate the Phoenix-Goodyear Airport.

The manufacturing facility used solvents and acids and generated metal sludges, waste solvents and waste acids from the metal treatment operations. Prior to 1980, much of these wastes were disposed on-site in sludge drying beds. There were one large and two small drying beds located at the southern portion of the facility. The contents of the beds, along with soil and rubberized fabric liner, were removed in 1980; further remediation of one of the beds was completed in 1993. TCE was used at the site prior to 1974, but no records are available indicating substantial on-site disposal (Ecology and Environment, 1983).

In 1988, a 25,000 gallon Underground Storage Tank (UST) was removed from the airport property and found to have released aviation gasoline. The total volume released was estimated to be 57,000 gallons. The tank was located in the infield area south of the main runway. Corrective actions conducted by the City of Phoenix under a 1993 Administrative Consent Agreement with EPA included drilling of eight exploratory borings, installation of ten groundwater monitoring wells, free product removal, and installation of a soil vapor extraction (SVE) system. The leaking tank site is being managed by the EPA's UST section and not by ADEQ. The SVE system is no longer in operation and regularly scheduled groundwater monitoring is ongoing (ADEQ, 2005). Because the spill is not related to the VOC and chromium contamination being addressed as part of PGAS remedial actions, it is not further discussed in this report.

3.4 Initial Response

A preliminary investigation was conducted by Ecology and Environment on behalf of EPA in September 1982. After sampling of wells in the area confirmed TCE contamination, the site was listed on the final NPL on September 8, 1983. A Remedial Investigation (RI) was conducted in 1984 and 1985. The RI consisted of sampling sewers and outfalls on the former GAC facility, installation of monitoring wells, completion of soil borings as piezometers, sampling of community wells, and collection of samples from surface soils and soil borings (USEPA 1989b). In addition, a site inspection was conducted in July 1983.

Results from the RI showed that there was a small area within one-half mile of the GAC facility in which production wells had TCE contamination in the range of 30 to 600 ppb (EPA, 1989b). The City of Goodyear shut down municipal production wells with VOC concentrations greater than respective MCLs (EPA, 1989a). Soil at the site was found to be contaminated with pesticides, chromium and other metals, and VOCs. Pesticides were present at levels that were considered consistent with background levels, while additional investigation and treatment was recommended for areas of metal and VOC contamination (EPA, 1989b).

3.5 Basis for Taking Action

3.5.1 Soil

Chromium was detected in soil at concentrations greater than the ADHS-suggested health-based cleanup level of 1,500 mg/kg. Other metals were also detected above regulatory levels, including aluminum, cadmium and copper. TCE was also detected in soil at levels greater than the ADHS-suggested soil cleanup level of 0.26 mg/kg. The highest health risks were determined to be from potential incidental ingestion of arsenic, chromium, cadmium and nickel in surface soils associated with the sludge drying beds (EPA, 1989b).

3.5.2 Groundwater

TCE was discovered in the groundwater at PGAS at concentrations greater than the MCL of 5 μg/L. In addition, chromium was detected in several wells at levels above the MCL of 100 μg/L. At the time of the RI, the City of Goodyear operated eight wells for its municipal water supply, seven of which were located within the PGA Superfund Site boundary (EPA, 1989b). Numerous other domestic and irrigation supply wells were also operating in this area (See Figure 3-1). As a result, the primary human health risk posed was the potential for direct ingestion of contaminated groundwater.

4.0 Remedial Actions

4.1 Regulatory Actions

Two RODs were signed for the PGAS site. The first, signed in 1987, addressed chromium and VOCs in groundwater in Subunit A for PGAS only and was called the Section 16 OU ROD. The second, signed in 1989, addressed the vadose zone and groundwater in Subunits B and C for both the PGAS and PGAN sites. An Action Memorandum for chromium removal at PGAS was signed in 1991 (EPA 1991c). A total of five ESDs were signed for the PGA site, although only four pertain to PGAS. The fifth ESD applies only to PGAN. In addition, for PGAS there were two Consent Decrees, signed in 1988 and 1991, and a Consent Order signed in 1992.

4.1.1 1987 ROD

The 1987 ROD addressed only contaminated groundwater in Subunit A, the upper portion of the UAU, at the PGAS site. Remedial determinations for Subunits B and C, and for contaminated soil at the site, were not made at this time because investigations were still taking place. In addition to TCE and chromium, perchloroethene (tetrachloroethene), 1,1-dichloroethene, chloroform, carbon tetrachloride and arsenic were identified in groundwater. The highest concentrations of these contaminants were found in Subunit A.

A wide range of alternatives was identified for the Section 16 OU. The selected remedy was to install a pump and treat system to remove contaminated groundwater from the aquifer. Contaminants were to be removed from the extracted water with an air stripping tower, with treatment of the off-gas by a vapor-phase granular activated carbon system. Treated groundwater was then to be reinjected into the aquifer through a network of Subunit A injection wells.

The objective of the Section 16 OU was to stop lateral migration of contaminants beyond Section 16 in Subunit A, to stop contaminants from migrating vertically into Subunits B and C, and to reduce the volume and toxicity of the contamination in Subunit A. The extent of chromium in Subunit A groundwater, as well as VOCs and chromium in Subunits B and C, was not precisely known at the time of the 1987 ROD, and treatment of these contaminants was to be addressed in the final remedy.

4.1.2 1989 ROD

The second and final ROD for the site addressed groundwater in Subunits B and C of the UAU, and VOC contamination of soil for the entire site (PGAS and PGAN). The preferred alternative for Subunits B and C groundwater was to use a new pump and treat system using air stripping to reduce VOCs to levels equal or less than the Applicable or Relevant and Appropriate Requirements (ARARs). Treated water would then be provided to current users of the extraction wells.

Treatment of contaminated soil was to be performed using a Soil Vapor Extraction (SVE) system covering approximately 284,100 square yards in area. The ROD did not require emission controls for the SVE system. This remedy addresses VOCs in the soil, but does not address chromium in the soil, which is addressed in the 1991 Action Memorandum (EPA, 1991c) (See Section 4.1.4).

4.1.3 Explanations of Significant Difference

The first ESD was issued in January 1991. There were five points to the ESD, two of which applied only to PGAN. Two points that applied to the entire site clarified the cleanup level for acetone in groundwater from 170 ppb to 350 ppb, and established a cleanup level for methyl ethyl ketone in groundwater at 700 ppb. The third point determined that wellhead treatment was not required at one offsite well, known as the Phillips Well.

The second ESD was issued in May 1993. There were several goals of this ESD, some of which applied to the southern portion of the site:

1. Change the requirement for a centralized air stripping system for the Subunit B/C groundwater remedy to a decentralized system;
2. Change the designated end use for water treated by the Subunit B/C groundwater remedy from municipal use to reinjection back into the Subunit B/C section of the aquifer with an option to reconsider municipal use after 1994;
3. Add the requirement that wellhead treatment shall be implemented at any private or municipal drinking water well in the vicinity of the PGA site that has an occurrence of a contaminant listed in Table 2-5 of the ROD in a concentration in excess of its groundwater clean-up standard, and;
4. Establish four additional groundwater clean-up standards: benzene (5 ppb), ethylbenzene (700 ppb), 1,1,2,2-tetrachlorethane (0.18 ppb) and tetrachlorethene (5 ppb).

The third ESD was issued in December 1995. This ESD modified the remedy selected for the site as follows:

1. Modify the groundwater remedy for Subunit A groundwater to allow air sparging in areas where an SVE system can collect and treat the VOC vapors emitted by the air sparging system in a manner consistent with the ROD; and
2. Modify the groundwater remedy for Subunit A groundwater to include use of a chromium adsorption wellhead treatment system, where appropriate, for wells connected to the existing groundwater treatment plant. This system would be used at any Subunit A groundwater remedy extraction well with chromium contamination that, without such a system, would result in the effluent at the Subunit A groundwater treatment plant exceeding site clean-up standards for metal contaminants.

The fourth ESD, issued in March 1998, updated the current groundwater clean-up standards for both Subunit A and Subunit B/C to be consistent with the Safe Drinking Water Act MCLs adopted in October 1996. The eight hazardous substances updated in this ESD included toluene, barium, beryllium, cadmium, chromium, lead, nickel, and selenium.

4.1.4 1991 Action Memorandum

An Action Memorandum was issued in October 1991 to address chromium in soil. The Action Memorandum set forth requirements for the excavation of the former sludge drying beds (EPA, 1991c). Any soil containing total chromium greater than 2,000 mg/kg or cadmium greater than 100 mg/kg was to be excavated and stabilized, with confirmation samples taken to ensure that the TCLP leachate did not exceed regulatory limits of 5.2 mg/kg for chromium and 0.066 mg/kg for cadmium.

4.1.5 Consent Decrees and Consent Orders

In 1988, EPA entered into a Consent Decree with GRTC to begin treating contaminated groundwater in Subunit A. The 1988 Consent Decree defined the remedial work to be performed, as stated in the 1987 ROD, identified quality assurance/quality control (QA/QC) protocol, and specified legal obligations and responsibilities (EPA 1988).

In 1991, a second Consent Decree was entered into between EPA and GTRC and Loral Defense Systems - Arizona (Loral). The 1991 Consent Decree updated the requirements of remedial actions to reflect issuance of the 1989 ROD. The requirements in the 1991 CD were to construct a treatment system to hydraulically contain the contaminants in Subunits B and C and reduce the contaminant concentrations to meet the clean-up standards stated in the ROD; to construct an SVE system to remove VOCs in the vadose zone; and to continue operation of the Section 16 OU treatment system as set forth in the 1987 ROD (EPA, 1989a) and 1988 CD (EPA, 1991b).

A Consent Order (CO) was entered into by EPA, GTRC and Loral in January 1992. Under the CO, GTRC and Loral would implement the actions specified in the 1991 Action Memorandum. Specifically, the 1992 CO provided for a removal action for soils at and adjacent to Chrome Sludge Drying Bed No. 2 containing more than 2,000 mg/kg total chromium or 100 mg/kg cadmium.

4.2 Remedial Action Objectives

The 1989 ROD set forth cleanup levels for the soil and groundwater at PGAS. The goal for remediation of VOCs in soil is to remove contaminants from the soil until the levels remaining will not cause or contribute to contamination of the groundwater above the groundwater cleanup standards. For chromium and other metals in soil, EPA set final cleanup levels through the 1991 Action Memorandum (EPA, 1991c). As with VOC contamination, the cleanup levels for soil are set such that remaining contamination will not contribute to groundwater contamination above the groundwater cleanup levels.

According to the 1989 ROD, groundwater throughout the aquifer - including Subunits A and B/C - must meet cleanup levels listed in Table 2-5 of the ROD. Although Subunit A is not a potential source of drinking water, pursuant to Arizona state law, cleanup must achieve the maximum protection of drinking water. Therefore, MCLs for all contaminants listed in Table 2-5 of the ROD apply to Subunit A groundwater unless treatment is not cost-effective, is not reasonable or necessary to protect human health or the environment, or is inconsistent with other aspects of Arizona water law. Cleanup levels have been modified in the second and fourth ESDs. Original and current cleanup levels, changes in cleanup levels as enacted in the ESDs, and 2005 MCLs, are discussed in Section 6.2.1 and listed in Table 6-1.

4.3 Remedial Action Implementation

The following section summarizes the remedial actions selected and implemented at PGAS, as well as the historical O&M activities associated with the remedy since startup in 1990.

4.3.1 Subunit A Groundwater

The Section 16 OU covers approximately 750 acres (EPA, 1987). Following the 1987 ROD, a pilot test for the air stripping and recharge system (chosen as the remedy for Subunit A groundwater) was conducted by GTRC. Based on the results of that pilot test, a full-scale treatment facility was constructed and began production in early 1990. At the beginning of operation, there were five extraction wells, one air stripper and seven injection wells (Sharp and Associates, 2005a). The offgas from the air stripping tower was treated with vapor-phase granular activated carbon until 1995. At that time, GTRC showed that VOC concentrations in the offgas were low enough that this was no longer required. During its use, the carbon was regenerated on-site with a thermal oxidizer.

The number of Subunit A extraction wells increased to 12 by 1995, and the number of injection wells increased to 14. The volume of water treated by the plant reached as high as 436 million gallons per year in 2001, and has decreased since that time. Slightly less that 200 million gallons were treated in 2004 (Sharp and Associates, 2005a). The current treatment system consists of the following:

- Twelve extraction wells, each capable of producing between 18 and 118 GPM (Sharp and Associates, 2004).
- Eighteen injection wells.
- Conveyance pipeline from extraction wells to the treatment system (influent).
- Acid tank for scale reduction.
- Air stripping tower.
- Conveyance pipeline from the treatment system to the injection wells (effluent).

The Subunit A treatment system does not currently remove chromium from the extracted groundwater. ESD #3 modified the groundwater remedy to include wellhead treatment for chromium. Pursuant to ESD#3, in the third quarter of 1995 a wellhead chromium treatment system was installed to treat water produced by Subunit A extraction well E-17, one of the wells with chromium concentrations above the MCL, prior to piping the water to the treatment plant for VOC removal by air stripping. The chromium treatment system used was an advanced affinity chromatography system which consisted of a chromatography column, prefilter, mechanical flow meter, regeneration system, sample ports and containment pad (Sharp and Associates, 1995b). The treatment system had many operational problems and was shut down in 2001. The treatment system was removed in 2003 with approval by ADEQ and EPA in December 2002 (ADEQ, 2002 and EPA, 2002b), and has not yet been replaced.

Air sparging was used twice at the site to accelerate VOC removal in different areas of the site. Air sparging is described in Section 4.3.4.

4.3.2 Subunit B/C Groundwater

There were originally three zones of contamination within Subunit C: the southern plume, the central plume and the northern plume (See Figure 4-6). Contamination is believed to have entered Subunit C from Subunit A through conduit wells. The known conduit wells were investigated in 1992 and either abandoned or repaired (Sharp and Associates, 1994b). Initially each of the three plumes has a separate extraction and treatment system. The northern system operated between February 1994 and December 2004 and consisted of two extraction wells, one liquid-phase granular activated carbon system and one injection well. The central system consisted of one extraction well and a reverse osmosis unit and operated for about 3 years. The southern system began operation in September 1994 and is still in operation.

The northern plume is believed to have entered Subunit C by conduit flow through well GAC #3, located near the southwest corner of Yuma Road and Litchfield Road. GAC #3 was rehabilitated in 1992 to prevent further contaminant migration. One extraction well, E-101, was installed near what was, at the time, the western edge of the plume. Water extracted from this well was routed through two pre-filters to two 15,000-pound liquid-phase granular activated carbon vessels installed in series, and then to two injection wells, I-101 and I-102. Treatment capacity for the Northern Subunit C system was rated at 450 gpm. The northern treatment system began operation in February 1994 using E-101 for extraction. E-101 was discontinued as an extraction well because it was not able to provide hydraulic containment of the plume, which had already migrated north of Yuma Road. A new extraction well, E-102, was installed in June 2003 and began operating in November 2004 to attain northern plume capture. The location of the well was selected using groundwater modeling and flow path analysis, and the well was installed at the leading edge of the northern plume to provide capture. The Northern Subunit C treatment system remains shut down, other than for periodic monitoring purposes, and the water extracted from E-102 is piped to the Southern Subunit C treatment system. Although groundwater modeling indicates that E-102 is capable of providing hydraulic capture of the Northern Subunit C plume, no monitoring wells are located in appropriate areas to prove that capture is occurring.

The Central Subunit C plume appears to be localized around well GAC #4, because the plume was associated with conduit flow through this well. This well was rehabilitated in 1992 to stop the conduit flow. Between 1992 and 1995, this well was used as the primary water source for the Loral Corporation facility, with extracted water treated with a reverse osmosis system and used on site. Treatment was required until 1995, when the TCE concentration in GAC #4 was below the drinking water standard for 12 consecutive months. This well is currently used as a backup well for the Loral facility. When in use, extracted water is treated with a reverse osmosis system and a granular activated carbon filter.

The Southern Subunit C treatment system is similar in design to the Northern Subunit C system. There are three extraction wells for the Southern plume, E-201, E-202 and E-203. Extracted groundwater is routed through two bag prefilters to two 15,000-pound liquid-phase granular activated carbon vessels. Treated water is reinjected through three Subunit C injection wells, I-201, I-202 and I-203. In November 2004, an additional well was added to the extraction network, when E-102 was put into operation north of Yuma Road to capture the northern Subunit C plume; water from E-102 is piped to the Southern Subunit C treatment system. All three initial Southern Subunit C extraction wells are currently in operation.

4.3.3 Vadose Zone

Several efforts were made to determine which areas of the site would be most suited for SVE treatment. All efforts involved using soil or soil gas analytical data from different polygonal areas of the site to predict the effect on TCE concentrations in groundwater below the polygons. In May 1992, a conservative total mass dissolution test was run on 143 polygons, of which 80 polygons failed, that is, were predicted to impact groundwater with TCE concentrations greater than 5 µg/L. VLEACH and a mixing cell model were then run on these 80 polygons, resulting in 14 polygons failing. Additional field data was collected in 1992 and 1993. Additional modeling took place, which resulted in selection of five polygons which required remediation using SVE. The polygon numbers were 79, 84, 96, 92 and 27a (See Figure 4-1).

The SVE system consisted of 5 major components: extraction wells and piping; vapor inlet system; vapor treatment system; vacuum extraction module; and electrical control system and power distribution module (Metcalf and Eddy 1993a). The number of extraction wells varied from 1 to 3 for each polygon. Flow from each well was piped through the vapor inlet system, which removed liquid from the inlet air and provided the opportunity to blend ambient air into the vapor stream to reduce the vapor concentration to below 25% of the Lower Explosive Limit, if needed. Offgases were treated with two 2,000-pound vapor-phase granular activated carbon vessels installed in series and vented to the atmosphere.

Polygon 79 was the first to be treated with the SVE system. The SVE system, using four extraction wells to remove VOCs from the soil, operated at Polygon 79 from September 1993 through January 1994. After monitoring rebound concentrations, the polygon was officially closed by EPA on September 3, 1994 (Metcalf and Eddy, 1995). The same SVE system was moved to Polygon 84 in 1994, and operated between late 1994 and early 1995. The Polygon 84 system used three extraction wells to remove VOCs from the soil. Confirmation samples were collected on June 15, 1995, and the polygon was approved for closure (Metcalf and Eddy, 1995a).

In late 1995, the SVE system was moved to Polygons 96, 92 and 27a. A total of seven extraction wells were installed to remove VOCs from the soil: three in Polygon 96, three in Polygon 92 and one in Polygon 27a. The system operated from March 1996 through April 1998. Air sparging was used to further reduce contamination in these three polygons and two adjoining polygons, numbered 81 and 100, between May 1996 and April 1998. During the operation of the SVE and air sparging systems at these five polygons, 1,768 pounds of VOCs were removed from the soil and groundwater. The impact to TCE concentrations in groundwater predicted by VLEACH modeling ranged from 6 µg/L in Polygon 27A to 27 µg/L in Polygon 96 prior to SVE treatment. After the treatment, the VLEACH-predicted impact to TCE groundwater concentrations was less than 1 µg/L for each of the polygons (Ogden Environmental and Energy Services, 1999).

4.3.4 Air Sparging

The use of air sparging was approved in ESD #3, issued in December 1995. Air sparging was performed by GTRC to help reduce the length of time required for site remediation. A pilot test was performed in late 1995 in Polygon 84 before the SVE system was moved to Polygon 96. The first full-scale air sparging program took place during the SVE treatment of Polygons 96, 92, and 27A. Four air sparging wells and three additional extraction wells were drilled in early 1996, and sparging operations began in May 1996. In December 1996, air sparging was also initiated in Polygons 81 and 100, two neighboring polygons which did not require SVE treatment. Air sparging continued until the SVE system was shut down in April 1998. During the length of SVE and air sparging treatment, 1,768 pounds of VOCs were removed from the soil and groundwater (Ogden Environmental and Energy Services, 1999).

After using air sparging in Polygons 96, 92, 27A, 81 and 100, a work plan was submitted to use the same system to accelerate VOC removal in the airport infield, just south of the UST release (GTRC, 1999). Three air sparging wells and four SVE wells were installed in 2001 near well PMW-15. The air sparging system operated between November 2001 and January 2003 and removed 138 pounds of TCE from the infield area (Sharp and Associates, 2005a).

4.3.5 Sludge Drying Beds

The 1983 site inspection identified three sludge drying beds located in the southern portion of the former GAC facility. The larger bed, measuring 100 feet by 190 feet (EPA 1989b) by three feet deep, was constructed in the early 1970s and was in use until 1980 (Ecology and Environment, 1983). It is not known when the two smaller beds, measuring 20 feet by 100 feet by three feet deep, were constructed or used. Prior to 1980, treated wastes from anodizing, metal etching, plating and plastics polishing and some solvents were disposed in the drying beds Waste consisted mostly of chrome sludge from the chromate treatment plant, with occasional disposal of waste solvent for evaporation. It is estimated that approximately 529,375 pounds of metals were disposed in the beds over their lifetime (Ecology and Environment, 1983). The material in the beds was removed in 1980, at which time one of the beds had a hard crust on top, but the deeper contents had not completely dried.

Work to remediate the two smaller sludge drying beds - a total area of about 100 feet by 140 feet - began in June 1992 and was completed in January 1993. The beds were excavated and soil segregated into stockpiles of clean, intermediate and contaminated material using a field instrument and samples submitted to an analytical laboratory. Cleanup standards for metals in soil were set by the October 1991 Action Memorandum (EPA, 1991c). Any soil containing total chromium at greater than 2,000 mg/kg or cadmium at greater then 100 mg/kg required stabilization prior to backfilling.

Before beginning excavation, the entire area was analyzed on a 25-foot grid system for chromium and cadmium levels using an X-Ray Fluorescence (XRF) detector. This allowed field staff to delineate areas that required excavation. These areas were excavated and the soil screened with XRF to determine whether it needed to be stabilized. A total of 1,696 cubic yards of contaminated soil and 1,895 cubic yards of intermediately-contaminated soil were removed from the former sludge drying beds. Comparison samples were collected in the excavated soil and submitted for laboratory analysis to confirm accuracy of the XRF.

Contaminated soil was blended with intermediate soil to reduce the concentration of metals in the soil to be stabilized. Stabilization was achieved by spreading Portland cement over the contaminated soil and mixing with a loader. Samples were taken of the stabilized soil to confirm that the TCLP leachate would be less than 5.2 mg/kg for chromium and 0.066 mg/kg for cadmium, as specified in the 1991 Action Memorandum (EPA, 1991c). Stabilized soil was compacted back into the excavated areas. The areas were covered with 6 inches of clean fill and a 3-inch layer of gravel. The site continues to be monitored for erosion but not for groundwater quality (Barthomolew Engineering, 1993).

4.4 Remedial Action Performance

4.4.1 Subunit A Groundwater

The Subunit A groundwater extraction and treatment system has successfully removed a large portion of the TCE mass in Subunit A groundwater. Figures 4-2 through 4-4 show the distribution of TCE in Subunit A in 1990, 1998 and 2004, respectively. Peak TCE concentrations have decreased from over 1,000 μg/L in 1990 to 190 μg/L in 2004, and the plume has decreased in width. According to the *Status of Subunit A Groundwater Cleanup and Groundwater Model Predictions* (Sharp and Associates, 2005a), the rate of TCE mass removal appears to be generally decreasing since a high point in 1994, when 863 pounds of TCE were removed. The amount of TCE removed varies independently from the volume of water treated, and the decreasing trend is not consistent - that is, the mass removed has risen in some years and dropped in others. This suggests that extraction regimes, as well as decreasing TCE concentrations, may be responsible for the decreased removal rates.

For example, during the second half of 2004, 55% of the extracted groundwater contained less than 5 μg/L of TCE, including 13% from one well that contained no TCE (TCE in NE-1 was reported as less than 1 μg/L). The four most contaminated wells, ranging from 88 to 190 μg/L TCE, contributed only 37% of the influent to the treatment plant (Sharp and Associates, 2005b). TCE removal rates may be greatly increased by altering the pumping schedule such that the most contaminated wells provide the bulk of the treatment plant influent water.

The 1987 ROD allowed for blending of extracted groundwater to meet the cleanup level for chromium as an interim measure. ESD #3 addressed removal of chromium from Subunit A groundwater through the addition of a metal adsorption wellhead treatment system. A chromium treatment system for groundwater was in operation between 1995 and 2001 at well E-17, but the system encountered many operational difficulties and has not been in use since 2001. As a result, chromium currently passes through the groundwater treatment system and is reinjected into the aquifer. Subunit A extraction wells containing chromium above the MCL of 100 μg/L are E-07R, E-12 and E-17, with concentrations of 450, 180 and 170 μg/L, respectively, in the second half of 2004 (Sharp and Associates, 2005b). The distribution of chromium in Subunit A is shown in Figure 4-5.

The presence of chromium in the groundwater complicates the removal of TCE mass. Because chromium is not currently being treated, the water from the extraction wells must be blended to achieve the regulatory limit of 100 μg/L in the treatment plant effluent. Since the three wells with the highest TCE concentrations also contain chromium above the regulatory limit (see Table 4-1), it is impossible to extract water with the highest TCE concentrations and still meet the MCL for chromium in reinjected treated water.

There is no record of a vapor intrusion assessment for groundwater in Subunit A or in Subunit B/C. Due to the depth to groundwater, there is no expected impact from contaminated groundwater to indoor air quality.

Table 4-1
Comparison of Extraction Well Flow Rates and Contaminant Concentrations, 2004
Phoenix Goodyear Airport (South) Superfund Site
City of Goodyear, Maricopa County, Arizona

Well	Cumulative Production (Mgal) 7/1/04 to 12/31/04	TCE (μg/L)	Chromium (μg/L)
NE-1	12	<1	94
NE-2	0	<1	63
NE-3	15.6	3	30
NE-4	7.6	88	53
NE-5	19	140	83
E-07R	2.7	98	450
E-08	0.2	14	50
E-10	0	NA	N/A
E-11	21.3	4.9	47
E-12	3.8	190	180
E-16	0	N/A	11
E-17	3.2	37	170

Source: Sharp and Associates 2005b
Notes:
Mgal = million gallons
μg/L = micrograms per liter
N/A = Not Available

4.4.2 Subunit B/C Groundwater

The Southern Subunit C groundwater treatment system has been effective in removing TCE mass and reducing the size of the plume, as shown in Figures 4-6 and 4-7. Concentrations of TCE in the southern Subunit C plume ranged as high as 200 μg/L in the airport infield area (Sharp and Associates, 1994b). In 2004, TCE concentrations in the vicinity of the southern plume ranged from non-detect to 55 μg/L (Sharp and Associates, 2005b).

The northern plume has become larger since the inception of remedial actions at the site. According to the *Final Operations Manual, Northern Subunit B/C Groundwater Remediation System* (Sharp and Associates, 1994a), the plume extended west from GAC #3 to GMW-9MC, a distance of approximately 600 feet. By 2004, the plume extended across Yuma Road and nearly one-half mile to the west (Figure 4-7). The location and design of the first extraction well installed in this area, E-101, was apparently not sufficient to contain the plume, possibly due to the groundwater divide that exists in this area. The 2003 addition of a second extraction well, E-102, was intended to provide plume capture. The location of E-102 was determined through groundwater modeling and flow path analysis, but there are no monitoring wells placed in appropriate areas to demonstrate that capture is being met.

In addition, due to the lack of sufficient monitoring points, it has not been demonstrated that the treatment systems provide vertical capture of the Subunit B/C plume.

The distribution of chromium in Subunit C groundwater is shown in Figure 4-8. Chromium in Subunit C groundwater, present in levels up to 235 μg/L in 2004, is not currently being treated.

4.4.3 Vadose Zone

Five polygon areas were determined through VLEACH and mixing cell modeling as described in Section 4.3.3 to require vadose zone remediation. SVE was used to remove contaminant mass from the vadose zone in these five polygons identified by the modeling effort. All five polygons have been approved for closure by the EPA (Metcalf and Eddy 1995a and Ogden Environmental, 1999).

There is no record of a vapor intrusion assessment for soils. However, residual TCE concentrations may present a risk to indoor air quality. For example, buildings overlie portions of Polygons 79 and 84, which contained TCE in shallow soil gas (13 to 16 feet) at levels up to 9,200 parts per billion by volume (ppbv) and 1,100 ppbv respectively, according to rebound monitoring conducted after cessation of SVE at these polygons (Metcalf and Eddy, 1994 and 1995b). In addition, there may be areas near or beneath buildings that were not remediated with SVE that may contain TCE at levels that do not pose a threat to groundwater as determined by VLEACH modeling, but may pose a threat to indoor air quality. Therefore, an evaluation of current soil gas conditions is suggested.

4.4.4 Sludge Drying Beds

The sludge drying beds were remediated in the 1980s and further remediated in 1992-1993, as described in Section 4.3.5. Remediation consisted of excavation of the contaminated soil, stabilization with cement, backfilling, and capping with native soil and gravel. No further action is likely to be needed for the sludge drying beds, although the area is monitored for erosion of the protective cap, as described in the *Chromium-Cadmium Response Action, Final Report Inspection Plan* (Bartholomew Engineering 1993). Periodic monitoring of area groundwater was also planned as part of the 1993 Inspection Plan, but is not currently being conducted.

4.5 Operation and Maintenance

4.5.1 Operation and Maintenance Activities

O&M of the treatment system is necessary to achieve the objectives set forth in the RODs and ESDs: containment of VOC- and metal-contaminated groundwater in the PGAS area, mass removal of VOCs, and treatment of extracted groundwater to concentrations less than MCLs. Specifically, appropriate and efficient O&M maximizes the operational time of extraction wells and the treatment plant to maximize contaminant removal. O&M manuals differ between the Subunit A treatment system and the Subunit B/C treatment systems. The main areas of each treatment system that require O&M are: extraction wells, air stripper or liquid-phase carbon vessels, and injection wells.

Operation reports are submitted to EPA as part of the Semiannual Groundwater Monitoring Reports. These reports include at a minimum (Sharp and Associates, 1994a):

- System operating time, downtime, and maintenance activities
- Quantity of water treated
- Primary liquid-phase carbon vessel influent and effluent concentrations
- TCE mass removed from the groundwater during the month

O&M of the treatment plants have been generally effective in maintaining the remedy at the site, although an update to the O&M manual is needed.

4.5.1.1 Subunit A Operation and Maintenance

The *PGA Operable Unit Treatment Plant Operation and Maintenance Procedures Manual* (ICF 1990) was submitted in January 1990 and has been periodically updated as the system has been modified. The manual lists operating parameters such as flow rates for extraction and injection wells, the pH range in influent and effluent water, and air flow rates through the air stripper. Regular maintenance activities are summarized below:

Weekly

Record flows from extraction wells, through treatment plant and to injection wells
Record pH of tower influent water, temperature of influent and effluent air, and air velocity for air stripper
Inspect piping for leaks and equipment at treatment plant for proper operation
Check acid tank secondary containment for liquid
Check pressure drop across air filters and clean or replace if necessary
Check level in liquid tanks
Drain water taps on the compressed air system
Purge air dryer and reset to 35 psi

Monthly

Check lubrication in acid feed pump
Clean strainer on line to operating injection pump
Switch operation between two injection pumps
Replace filters on blower and clean the old filters
Check air compressor intake filters
Record hours of air compressor use
Check dessicator on top of acid tank
Record highest water levels reached in each injection well
Check proper operation of solenoid in each injection well vault

Semi-Annually

Drain acid supply line and strainer

Replace strainer in acid feed line
Replace lube oil in acid feed pump
Calibrate in-line pH sensor
Lubricate bearings on injection pumps
Clean strainers at the injection wellheads
Clean out well vaults.
Check belts on air blower and lubricate
Inspect tower packing

4.5.1.2 Subunit B/C Operation and Maintenance

The *Operation and Maintenance Manual for the Northern Subunit B/C Groundwater Remediation System* was submitted for EPA approval in April, 1994 (Sharp and Associates, 1994a). Operation and maintenance of the southern Subunit B/C system is similar to the northern system, and the Operation and Maintenance Manual has not been substantially updated since it was written in 1994. Frequency of operation and maintenance tasks are listed below:

Weekly

Record water levels in extraction and injection wells
Record water levels in monitor wells
Record pressure in pre-filters, GAC units and injection wells
Record water flow rates on extraction and injection wells
Check bag filters and replace if needed

Monthly

Read electric meter
Sample water at influent and between GAC vessels
Confirm calibration of electronic sensors
Inspect extraction well pumps for oxidation and moisture

Currently, the northern Subunit B/C system is shut off because the northern plume (groundwater from E-102) is being treated by the southern Subunit B/C treatment system and the northern system is used only once each month to collect a sample. The plan is to keep this system turned off indefinitely and use only E-102 for extraction from the northern Subunit B/C plume to reduce operation and maintenance costs.

The wellhead treatment system for central Subunit B/C well GAC #4 (the central Subunit B/C plume) is not currently operated. This well served as the primary water source for the Loral Corporation and had wellhead treatment in place from 1992 until 1995, when the TCE concentration was below the drinking water standard for 12 consecutive months. The well now serves as a backup well for the Loral facility; when operated water is treated by RO and granular activated carbon.

4.5.2 Operation and Maintenance Costs

During a site inspection conducted on April 28, 2005, GTRC personnel stated that the estimated annual operation and maintenance cost for the site was $820,000 in 2003 and $820,000 in 2004. The budget for 2005 was set at $702,000, with the reduction attributed primarily to eliminating the operation of the Northern Subunit B/C treatment system and directing flow from E-102 to the Southern Subunit B/C treatment system. This includes operation of all treatment systems and maintenance of the treatment systems, extraction wells, injection wells, monitoring wells and piping.

Occasional incidents have incurred unexpected maintenance costs. In the past five years these incidents include pump failures, a leak in one of the influent water lines, a failure of the acid tank at the Subunit A groundwater treatment plant and the maintenance of electric lines that were buried without conduit.

5.0 Five-year Review Process

The following sections discuss activities of the five-year review.

5.1 Five-year Review Process

Mary Aycock, EPA Remedial Project Manager, led the PGAS five-year review.

The five-year review consisted of: a review of relevant documents (Appendix A); a regulatory review; interviews with staff associated with GTRC, staff responsible for O&M of the treatment system, staff from the state regulatory agency (ADEQ), and staff from the main property owner (City of Phoenix); and a site inspection.

Notice that the five-year review was to be performed was given to the Community Advisory Group (CAG) during meetings on June 9, 2005 and August 11, 2005. Following the release of this document, EPA will inform the public that this review has been completed and provide instructions on how to access a copy of this review. Results from the five-year review will be summarized in a fact sheet to be issued in September 2005, and will also be presented at the next CAG meeting on October 6, 2005.

5.2 Documents Review

As a part of the five-year review process, CH2M HILL conducted a brief review of numerous documents related to site activities. Since this is the first five-year review, documents included the original 1987 and 1989 RODs, all ESDs, the 1991 Action Memorandum, design documents, operation and maintenance plans, site inspections and other documents dating back to 1983. Appendix A provides a list of the documents reviewed as part of this report.

5.3 Data Reviewed

Semiannual groundwater monitoring reports are submitted to ADEQ and EPA by Sharp and Associates. The data review in Sections 4.3 and 4.4 is based in large part on the two most recent semi-annual groundwater monitoring reports. These reports describe the status of the contaminant plumes in Subunits A and B/C, the TCE mass removed, treatment system performance, and field activities conducted during the reporting period. Routine activities include:

- Monthly monitoring of TCE and chromium in treatment system influent and effluent;
- Quarterly measurement of groundwater elevations in monitoring, extraction and injection wells at the site;
- Quarterly sampling of extraction wells; and
- Semi-annual collection of samples from the monitoring wells;

Sharp has also submitted a report entitled *Status of Subunit A Groundwater Cleanup and Groundwater Model Predictions* (Sharp and Associates, 2005a) which describes data trends in Subunit A groundwater and proposes shutting down the Subunit A groundwater pump-and-treat system. Additional historical data was found in the RODs, Remedial Investigations, Feasibility Studies and design documents listed in Appendix A. Review of these data sources contributed to the evaluation of remedial action performance as described in Sections 4.3 and 4.4.

5.4 Regulatory Review

The regulatory review encompasses Applicable or Relevant and Appropriate Requirements (ARARs) and Institutional Controls (ICs). These are described in the following sections.

5.4.1 Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA requires that remedial actions implemented at CERCLA sites attain any Federal or more stringent State environmental standards, requirements, criteria, or limitations that are determined to be ARARs.

Applicable requirements are those cleanup standards, criteria, or limitations promulgated under Federal or State law that specifically address the situation at a CERCLA site. A requirement is applicable if the jurisdictional prerequisites of the environmental standard show a direct correspondence when objectively compared with the conditions at PGAS.

If a requirement is not legally applicable, the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations sufficiently similar to the circumstances of the proposed response action and are well-suited to the conditions of PGAS. The criteria for determining relevance and appropriateness are listed in 40 CFR 300.400(g)(2).

Pursuant to EPA guidance, ARARs generally are classified into three categories: chemical-specific, location-specific, and action-specific requirements. These classification categories were developed to help identify ARARs, some of which do not fall precisely into one group or another. These categories of ARARs are defined below:

- **Chemical-specific ARARs** include those laws and requirements that regulate the release to the environment of materials possessing certain chemical or physical characteristics or containing specified chemical compounds. These requirements generally set health- or risk-based concentration limits or discharge limitations for specific hazardous substances. If, in a specific situation, a chemical is subject to more than one discharge or exposure limit, the more stringent of the requirements should generally be applied. The majority of ARARs applicable to PGAS are chemical-specific ARARs, as discussed in the next section.

- **Location-specific ARARs** are those requirements that relate to the geographical or physical position of PGAS, rather than the nature of the contaminants or the proposed remedial actions. These requirements may limit the placement of remedial action, and may impose additional constraints on the cleanup action. For example, location-specific ARARs may refer to activities in the vicinity of wetlands, endangered species habitat, or areas of historical or cultural significance. There are no location-specific ARARs for PGAS.

- **Action-specific ARARs** are requirements that apply to specific actions that may be associated with remediation. Action-specific ARARs often define acceptable handling, treatment, and disposal procedures for hazardous substances. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Examples of action-specific ARARs include requirements applicable to wastewater discharge and emissions of air pollutants. For PGAS, wastewater discharge must meet the chemical-specific ARARs, and air pollutants must meet Maricopa County Air Quality Rules, as discussed below.

To-be-considered (TBC) criteria are requirements that may not meet the definition of an ARAR as described above but still may be useful in determining whether to take action at a site or to what degree action is necessary. This can be particularly true when there are no ARARs for a site, action, or contaminant. TBC criteria are defined in 40 CFR 300.400(g)(3). Chemical-specific TBC requirements are applied in the absence of ARARs or when the existing ARARs are not sufficiently protective to develop cleanup levels. TBC documents are non-promulgated advisories or guidance issued by federal or state government that are not legally binding but that may provide useful information or recommended procedures for remedial action. Although TBC criteria do not have the status of ARARs, they are considered together with ARARs to establish the required level of cleanup for protection of human health or the environment. The critical difference between a TBC and an ARAR is that one is not required to comply with or meet a TBC when deciding on a remedial action. There are no known TBC criteria for PGAS.

The purpose of this regulatory review is to determine if regulations promulgated since the issuance of the documents described below may now impact the protectiveness of the remedy on human health and the environment. In the preamble to the final National Contingency Plan, EPA states that it will not reopen remedy selection decisions contained in RODs unless a new or modified requirement calls into question the protectiveness of the selected remedy (55 FR 8757, March 8, 1990).

Changes to ARARs are presented in Section 6.2.1.

5.4.2 Institutional Controls

Institutional controls (ICs) are non-engineering methods by which access to contaminated environmental media is restricted. For example, these may include restrictions or limitations on access, media use or property use. Because there is contamination in both soil and groundwater that prevents unrestricted use or unrestricted exposure, ICs should be considered for the site. Documents reviewed for this five-year review include the 1987 and 1989 RODs, the 1988 and 1991 CDs, the 1992 CO, and all ESDs that apply to the site. A title search and a review of ordinances and other governmental controls were not conducted.

There is an institutional control on the use of groundwater at the site. Although ICs were not required in the 1987 ROD or 1989 ROD, the 1991 Consent Decree, which applied to

GTRC and Loral Defense Systems, included a provision preventing the installation or use of groundwater wells at the site for human consumption unless the extracted water is treated to meet drinking water standards.

No restrictions on excavation at the site were found during the five-year review. Further, Arizona's Well Spacing and Well Impact Rules (Arizona Administrative Code §R12-15-830) prevents drilling of any new production wells that may adversely impact groundwater remediation systems or hydraulic capture of groundwater contamination plumes.

The five year review did not reveal any institutional controls on access to the site. However, access is largely controlled by fencing around the airport property and other commercial or industrial properties at the site. The fencing is intended for security purposes, not to prevent access to contaminated media, but is effective in doing both.

Additional institutional controls may be required if the site does not meet requirements for unrestricted use and unrestricted exposure. For example, it may be necessary to attach a restriction to property deeds to prevent excavations, particularly in the vicinity of the former sludge drying beds. An additional example of institutional controls that could be implemented at the site would be further restrictions on groundwater use in the area. If the end use of the treated groundwater changes, for example, to irrigation, municipal or process water, there may also need to be institutional controls on the use of the water.

5.5 Ecological Risk Assessment

5.5.1 Introduction

A detailed ecological risk evaluation was not conducted as part of the 1989 Remedial Investigation (EPA, 1989b). Consequently as part of this review, a simple screen of residual concentrations of the primary human health risk drivers identified in the RI was conducted to determine if the human health-based remediation was also protective of ecological receptors. The primary human health risk drivers were identified as chromium and cadmium in soil, and TCE in groundwater and soil.

Available soil benchmarks for terrestrial ecological receptors (i.e., plants, soil invertebrates, birds, and mammals) were compared to surface soil boring concentrations. Contaminated areas at the site were divided into two categories: those that were excavated and those that were not excavated. The ADHS human health-based cleanup levels, on which the prior remediation was based, were compared against current ecotoxicological benchmarks to see if the prior remediation was adequate to protect ecological receptors. According to the *Chromium-Cadmium Response Action Final Report* (Bartholomew Engineering, 1993), some contaminated areas were not excavated because contaminant concentrations were at or below ADHS human health based cleanup levels. Soil borings from these areas were also compared to current ecotoxicological benchmarks to determine whether additional characterization, evaluation, and possibly remediation would be necessary to protect ecological receptors.

The evaluation of prior remediation is presented below, grouped by each of the primary human health risk drivers.

5.5.2 Chromium

In the absence of ecological screening-levels (Eco-SSLs) for chromium for plants and soil invertebrates, soil benchmark values from the Oak Ridge National Laboratory (Efromyson et al. 1997a, b) were used to evaluate residual soil chromium concentrations. Plant and soil invertebrate benchmark values were 1.0 and 0.4 mg/kg, respectively. Eco-SSL benchmarks for terrestrial birds and mammals were available from EPA, and were 81 and 26 mg/kg, respectively (EPA, 2005a). Because the naturally occurring background concentration for chromium in the area is 30 mg/kg (EPA, 1989b), the ecological threshold (values that will be compared against) was truncated at 30 mg/kg. This soil level of 30 mg/kg is significantly lower than the ADHS human health cleanup value of 1,000 mg/kg.

5.5.2.1 Chromium Sludge Bed No. 1

This area, which was not excavated because maximum concentrations did not exceed the ADHS chromium cleanup value, had surface soil (0-15 inches) chromium levels that ranged from 41 mg/kg to as high as 525 mg/kg. Soil borings that exceeded the ecological threshold for chromium included borings 601, 602, 604, 606, and 608. Because existing soil concentrations exceeded the selected ecological threshold for chromium (30 mg/kg), additional evaluation of this area should be considered.

5.5.2.2 Chromium Sludge Bed No. 2 (incorporated Chromium Sludge Bed No. 3)

This area was remediated based on the 1991 Action Memorandum (EPA, 1991c) based on the excavation criteria of 2,000 mg/kg. Given that the area was excavated to a depth of 7 feet and was capped with clean soil and gravel to a depth of 9 inches, ecological exposure pathways in the excavated areas are believed to be interrupted and therefore ecological risks are considered trivial. Residual chromium levels in soil in portions of this area that were not excavated, however, did exceed the ecological threshold of 30 mg/kg. Boring locations 705 and 706, which were not part of the excavation, had chromium concentrations at 398 and 131 mg/kg in the top 0-4 inches (EPA, 1998b). Because existing soil concentrations exceeded the selected ecological threshold for chromium, additional evaluation should be considered.

5.5.2.3 Former Sewage Treatment Facility

None of the 5 shallow (0.5 to 1.5 feet) soil samples summarized in the RI (EPA, 1989b) exceeded the chromium threshold. The maximum soil concentration was at 30 mg/kg. No additional evaluation is recommended because they are consistent with the threshold value of 30 mg/kg.

5.5.2.4 Airport Drain Ditch near the Outfall of Drain 001

Of the 5 shallow (5.5 to 6.5 feet) soil samples, 3 exceeded chromium threshold values. Concentrations of soil ranged were measured at 43, 54, and 54 mg/kg. Additional evaluation is recommended.

5.5.2.5 Former Paint Tent Area

Only one sample in the surface soil marginally exceeded the chromium threshold (31 vs. 30 mg/kg giving an hazard quotient of 1.03). Thus, this area is considered to be largely protective of ecological receptors and additional evaluation is not recommended.

5.5.2.6 Hangar Apron Area

None of the four surface soil samples exceeded the chromium threshold. The maximum concentration was reported at 23 mg/kg. No additional evaluation is recommended.

5.5.3 Cadmium

Eco-SSL ecological benchmarks for plants (32 mg/kg), soil invertebrates (140 mg/kg), mammals (0.36 mg/kg), and birds (0.77 mg/kg) were available (EPA, 2005b). Because the local background concentrations for cadmium is 1.2 mg/kg (EPA, 1989b), the ecological threshold for cadmium is truncated at 1.2 mg/kg. This value is lower than the ADHS soil cleanup value of 10 mg/kg (EPA, 1989b).

5.5.3.1 Chromium Sludge Bed No. 1

This area, which was not excavated because maximum concentrations did not exceed the ADHS cadmium cleanup value, had surface soil (0-15 inches) cadmium levels that ranged from 4.8 mg/kg to as high as 23.8 mg/kg. Soil borings that exceeded the ecological thresholds included borings 602, 603, 604, and 606, and 608 (EPA 1989b). Because existing soil concentrations exceeded the selected ecological threshold for cadmium (1.2 mg/kg), additional evaluation of this area should be considered.

5.5.3.2 Chromium Sludge Bed No. 2 (incorporated Chromium Sludge Bed No. 3)

This area was remediated based on the 1991 Action Memorandum (EPA, 1991c) excavation criteria of 100 mg/kg. Given that the excavated areas were capped with clean soil and gravel to a depth of 7 feet, ecological exposure pathways in the excavated areas are believed to be interrupted and therefore ecological risks are considered trivial. Residual cadmium levels in soil in portions of this area that were not excavated however do exceed the ecological threshold of 1.2 mg/kg. Boring location 705, which was not part of the excavation, had cadmium concentrations at 15 mg/kg in the top 0-4 inches (EPA 1989b), exceeding the threshold value of 1.2 mg/kg. Because existing soil concentrations exceeded the selected ecological threshold for cadmium, additional evaluation should be considered.

5.5.3.3 Former Sewage Treatment Facility

Only one cadmium sample was available at this facility (EPA 1989b). The measured concentration of cadmium was 8 mg/kg, which is higher than the cadmium threshold of 1.2 mg/kg. Because of the limited sample available, additional evaluation is recommended.

5.5.3.4 Airport Drain Ditch near the Outfall of Drain 001

No cadmium sample data were available in this area (EPA 1989b). Additional evaluation is recommended.

5.5.3.5. Former Paint Tent Area

No cadmium sample data were available in this area (EPA 1989b). Additional evaluation is recommended.

5.5.3.6 Hangar Apron Area

No cadmium sample data were available in this area (EPA 1989b). Additional evaluation is recommended.

5.5.4 TCE

TCE was considered a human health risk in groundwater and soil. Because TCE is a VOC, persistence in surface soil will be limited. In addition, the depth to groundwater at the site is approximately 60 feet (Sharp and Associates, 2005b). Because activities of most animals at the site will be limited to the surface 1-2 feet and few, if any plants, will have roots extending to the groundwater, ecological exposure to TCE is likely to be trivial. Consequently, ecological risks from TCE are considered unlikely.

5.5.5 Conclusions

The conclusion of the ecological review is that prior remediation for chromium and cadmium for human health may not be adequately protective of ecological receptors. Additional evaluation of potential chromium and cadmium impacts should be considered for the Chrome Sludge Bed No. 1, Chrome Sludge Bed No. 2, and the airport drainage ditch near Outfall Drain 001 areas. Additional evaluation for cadmium should be considered for the former sewage treatment facility, the former paint tent area, and the hangar apron area. Additional evaluation of TCE for ecological receptors appears to be unwarranted.

5.6 Site Inspection

Representatives of CH2M HILL performed a site inspection of the PGAS facility on April 28, 2005. The inspection was also attended by representatives of GTRC and their O&M contractor, Bartholomew Engineering. GTRC personnel provided a brief overview of the site layout and a description of the various treatment systems. The inspection included the Subunit A treatment system, the Northern and Southern Subunit B/C treatment systems, the location of the former sludge drying beds, several representative extraction, injection and monitoring wells, and a driving tour of the site perimeter and neighboring areas. The PGAS inspection checklist and photos are provided in Appendices B and C, respectively. Conditions during the inspection were favorable, with mild temperatures and no precipitation.

All inspected areas were secured with adequate fencing. The monitor wells located on the airport property were not individually fenced, but generally had locks. Most of the monitor and injection wells observed during the inspection, particularly those close to the airport runway or taxiways, were in underground, flush-mounted vaults. Equipment is generally well-maintained, but is showing signs of age. In particular, some of the wellhead piping at the extraction wells is rusted and may be in need of replacement. Missing caps on above-grade monitor well discharge pipes and sounding tubes were not uncommon.

The Subunit A treatment plant was operating at the time of the site visit. The acid tank, air stripping tower, GAC system, and associated piping were visually inspected. The equipment generally appeared in good condition, although there was some corrosion apparent on the acid tank. The tank was located in a secondary containment pad.

The Subunit A treatment plant office appeared to contain all necessary project information. The Emergency Response Plan, O&M manuals, maintenance log books, permits, Material Safety Data Sheets, and other project specific information were readily available, although the O&M manual was considerably out of date. Although it has been updated since plant operation began, it should be completely revised to reflect all new equipment and procedures. Current operations data can be accessed remotely, and the system can be operated remotely due to the addition of telemetry.

The Southern Subunit B/C treatment plant was operating at the time of the site visit. The extraction well E-201, the GAC vessels and associated piping were visually inspected and appeared in good condition, although there was a slight leak from the packing of the turbine pump at E-201. The office contained all necessary project information. E-102, which extracts water from the northern Subunit B/C plume but routes water to the southern Subunt B/C treatment system, was also inspected. There was a larger leak from the packing at this well (see photo 10 in Appendix C). Site personnel stated that this pump has had problems in the past and would inquire as to whether the pump was covered under manufacturer's warranty. Injection well I-202 was offline because scaling within the well had reduced the injection capacity of the well. Due to this reduction in injection capacity, extraction well E-202 was also offline. These are considered short-term issues that do not affect the overall effectiveness of the remedy.

The Northern Subunit B/C treatment plant was not operating at the time of the site visit. As described in Section 4.3.2, this system is no longer in regular use, and is operated only once per month for required sampling purposes. The extraction well E-101, the GAC vessels and associated piping were visually inspected and appeared to be in good condition. The office appeared to contain all necessary project information.

The Central Subunit B/C treatment system is not currently operating because cleanup levels were met in 1995. As described in Section 4.3.2, the well operates as a backup well for the Loral facility. This system was not inspected during the site visit.

5.7 Interviews

Interviews were conducted with personnel from the City of Phoenix Aviation Department, GTRC, Bartholomew Engineering and Arizona Department of Environmental Quality. Interview summary forms are provided in Appendix B.

On April 28, 2005, the following people associated with PGAS were interviewed in person:

- Jeff Sussman, GTRC Project Manager
- Richard Bartholomew and David Bartholomew, Bartholomew Engineering, Treatment Plant Operators (combined interview)

At a later date, by telephone, the following people associated with PGAS were interviewed:

- Nancy Lou Sandoval, ADEQ Project Manager
- Cynthia Parker, City of Phoenix Aviation Department Project Manager

Jeff Sussman has been the GTRC Project Manager for the site since 2001, and during the interview he gave an overview of the site history and system operations. Mr. Sussman described the treatment system as successfully reducing contaminant concentrations. He also suggested using a risk-based approach to determining cleanup levels for Subunit A groundwater, rather than applying the MCLs as required by the 1987 ROD and subsequent ESDs.

Richard and David Bartholomew of Bartholomew Engineering have been with the project since the Subunit A treatment system was first started in 1990. Like Mr. Sussman, they both stated that the treatment systems have been successful in reducing contaminant concentrations at the site. They also suggested changing the remedial technology for Subunit A groundwater from pump-and-treat to monitored natural attenuation (MNA).

Nancy Lou Sandoval has been the ADEQ Project Manager since 1999. She expressed satisfaction at remedial progress at the site, but suggested that changing to risk-based cleanup levels may not be appropriate at this time. The system has been operating for 15 years, and while TCE levels have decreased substantially during this time, the TCE remains at elevated levels, and the TCE plume could be reduced further if the chromium was treated.

Cynthia Parker has been the co-Project Manager for the City of Phoenix airport property for several years. She stated that the cleanup appears to be going well and that GTRC has been willing to work with the City of Phoenix on logistical issues and has been working to optimize operations at the site. Ms. Parker expressed some reservations about altering the cleanup standards at the site, as leaving contamination above the MCL would not allow for unrestricted use of the site and would require some type of deed restriction agreement between GTRC and the City of Phoenix.

All interviewees expressed satisfaction with the operation of the treatment systems and indicated that the remedy was generally effective. There was general consensus, however, that the chromium above the MCL in Subunit A prevented optimum extraction of TCE. Relations between all parties appeared to be amiable.

6.0 Technical Assessment

This section evaluates the functioning of the remedy as intended by decision documents, the current status of assumptions, and new information affecting the remedy.

6.1 Functioning of the Remedy as Intended by Decision Documents

6.1.1 Soil

The remedy selected to achieve the cleanup standards for VOCs in soil was SVE. Vapor contaminant transport modeling was conducted to determine target areas for the SVE treatment. Five polygons were identified which required this treatment. These five polygons were treated sequentially with a single SVE system between December 1993 and April 1998. Rebound monitoring took place and confirmation soil gas samples were collected from each polygon to support closure modeling. Each of the five polygons were approved for closure by EPA. Air sparging with SVE were implemented in limited areas of the site between 2001 and 2003. The soil remedy functioned as intended by the 1989 ROD.

Remedial goals for chromium and cadmium in the former sludge drying beds were presented in the 1991 Action Memorandum (EPA, 1991c). The remedy selected to achieve cleanup standards for chromium and cadmium in soils was excavation and stabilization. The 1992 Consent Order included the requirement to excavate and stabilize soils containing more than 2,000 mg/kg total chromium or 100 mg/kg cadmium to prevent formation of a leachate in excess of the RCRA Land Disposal Restrictions of 5.2 ppm for chromium and 0.066 ppm for cadmium.

The remedial action took place between June 1992 and January 1993. An XRF field instrument was used to help delineate the areas requiring excavation, and samples were collected to verify accuracy of the instrument. The excavated soil was segregated by contaminant levels, blended to reduce contaminant levels in the most contaminated soil, stabilized with cement and backfilled into the excavated area. Geotechnical and chemical analyses were performed during the remedial process to ensure that the actions were performing according to specifications. The remedy functioned as intended by the 1991 Action Memorandum.

6.1.2 Subunit A Groundwater

As described in the 1987 ROD, the remedial goal for Subunit A was to meet cleanup standards and prevent contaminant migration laterally and vertically into Subunits B and C (EPA 1987, 1989a). For the two primary contaminants at the site, TCE and chromium, this meant achieving the MCL of 5 μg/L for TCE and 50 μg/L for chromium. The standard for chromium was later raised to 100 μg/L in in ESD #4. Previous and current cleanup levels are summarized in Table 5-1.

The remedy selected for VOC removal was groundwater pump-and-treat with reinjection upgradient of the contaminant plume. The remedial system has been successful in reducing the amount of TCE in Subunit A from the peak concentrations that existed prior to startup of the system. However, there are two issues which negatively impact the remedy for Subunit A groundwater: the length of time required to meet the cleanup level for TCE, and the lack of treatment for chromium. These issues are discussed below.

1. The maximum TCE levels in late 2004 were at approximately 190 μg/L, which is significantly above the MCL of 5 μg/L, indicating that many more years of treatment will be required. Modeling performed by Sharp and Associates has generated estimates of 12 to 16 additional years of treatment for Subunit A groundwater to reach the MCL (Sharp and Associates, 2005b).

2. In accordance with ESD#3, chromium removal from well E-17 was conducted between 1995 and 2001. In 2001, the chromium treatment system was shut down due to operational problems and was removed in 2003 with approval by ADEQ and EPA (ADEQ 2002, EPA 2002b). Currently, chromium is present at concentrations up to 450 μg/L, based on late 2004 data, which is significantly above the MCL of 100 μg/L. Chromium is not currently being removed from the aquifer. Because there is no chromium treatment in place, influent water must be blended to achieve the discharge limit of 100 μg/L in the treatment plant effluent. Although this may eventually reduce the chromium concentration to below the MCL throughout the aquifer, it will be accomplished through contaminant redistribution, not removal. It is also preventing optimum removal of TCE from the aquifer, as discussed in Section 4.4.

Despite these issues, the remedy is decreasing contaminant levels towards the cleanup levels. In addition, the system appears to provide containment of the Subunit A plume onsite, such that off-site lateral migration is not occurring. The active pump-and-treat operations are also likely limiting vertical migration of contaminants to Subunit B/C, and this objective has also been addressed through closure of known conduit wells. Therefore it appears that the Subunit A groundwater remedy is functioning as intended by the 1987 ROD, although it is not functioning as intended by ESD #3 for chromium removal.

6.1.3 Subunit B/C Groundwater

The 1989 ROD addressed remediation of groundwater from Subunit B/C. Because Subunit C is an important source of drinking, irrigation and process water for the area, the cleanup goals, as described in the ROD, are to contain the plume and reduce contaminant concentrations to meet the ARARs, which are based on MCLs and ADEQ Action Levels. This is accomplished using groundwater pump-and-treat systems. Treatment systems for the Central and Southern Subunit B/C treatment systems have been largely successful in containing the groundwater plumes and reducing the contaminant concentrations, although there are some questions about containment, as described below.

The Northern Subunit B/C treatment system and associated extraction well began operation in February 1994, and ultimately was not successful in containing the northern extent of the plume. A second extraction well, E-102, began operation in November 2003 at the leading edge of the plume, in a location dictated by numerical groundwater flow modeling. The location for this new extraction well was determined using flow path modeling to provide containment of the northern portion of the plume. Although groundwater modeling was used to determine optimum placement of E-102, there are insufficient monitoring points to effectively demonstrate that capture is being achieved. Water from E-102 is routed to the Southern Subunit B/C treatment system. The Northern Subunit B/C treatment system (and it's original extraction well) have been shut off and is only turned on briefly once per month for sampling purposes. TCE was detected in E-102 at a level of 4.9 µg/L in late 2004 (Sharp and Associates, 2005a). Issues identified for the Northern Subunit B/C plume are:

1. Although the groundwater flow modeling suggested that containment would occur with E-102, there are currently no monitoring wells located downgradient or crossgradient of E-102, so containment has not been verified.
2. In addition, E-101 is located near the highest concentrations of chromium in Subunit C, and with cessation of pumping from this well, there is limited removal of chromium from the northern Subunit B/C plume. The chromium is expected to migrate towards E-102, but as mentioned above, hydraulic containment has not been demonstrated with field sampling. Also, since there is currently no treatment for chromium, reduction in concentration relies on redistribution within the aquifer which, although it may eventually meet the MCL of 100 µg/ L, it does not constitute removal or treatment as required by CERCLA.
3. Vertical containment of the northern Subunit B/C groundwater plumes has not been demonstrated.

The Central Subunit B/C treatment system consisted of a single extraction well (GAC #4) and an RO system. The well was rehabilitated in 1992 to prevent the downward migration of contaminants. By 1995 the contaminant levels had been reduced and were confirmed at levels below the MCL for 12 months, and the well was shut down. It is now used as a backup well for the Loral facility, and when used is treated by RO and granular activated carbon.

The Southern Subunit B/C treatment system and associated extraction wells began operation in September 1994. The system appears to be meeting the objective of containing further lateral migration of the plume. Also, the system has reduced the amount of TCE in Subunit A from the peak concentrations that existed prior to startup of the system. The issues identified for the Southern Subunit B/C plume is:

1. The maximum TCE levels in late 2004 were at approximately 100 µg/L, which is significantly above the MCL of 5 µg/ L, indicating that treatment will be required for many years to come.
2. Vertical containment of the southern Subunit B/C groundwater plume has not been demonstrated.

The remedy is generally functioning for VOC removal as intended by the 1989 ROD for the southern plume. It is not clear whether the remedy for the northern and central plumes are meeting all remedial objectives.

6.2 Current Validity of Assumptions Used During Remedy Selection

The assumptions made at the time of remedy selection are generally unchanged. Although the cleanup levels for lead and cadmium have been reduced, these were not identified as primary contaminants in the 1989 ROD, possibly because they are less widespread than chromium and are less toxic. The reduction of cleanup levels does not affect the appropriateness of the selected remedy.

Although land use in much of the area has changed from agricultural to residential, the exposure pathways have remained the same. The soil has been remediated and is located in industrial areas; however, vapor intrusion from any residually impacted soils into adjacent buildings was not assessed and may require further investigation. In addition, potential ecological impacts from residual metals in soils has not been conducted. Groundwater is not accessible to residents as long as the production wells are protected through monitoring and groundwater treatment. Changes in land use do not affect the appropriateness of the remedy.

There has been no change in remedial action objectives, although there has been discussion of changing the cleanup goals for Subunit A from MCLs to a risk-based cleanup level. Remediation is progressing towards the remedial goals.

6.2.1 Changes in Applicable or Relevant and Appropriate Requirements

ARARs were reviewed in Appendix I of the 1989 RI/FS (EPA, 1989b), at which time there did not appear to be any ARARs directly related to contamination in soil. The only guidelines were ADHS-suggested health-based cleanup levels. The ARARs for groundwater were the Safe Drinking Water Act (SDWA) MCLs, Arizona Water Quality Criteria, ADEQ Action Levels, and federal proposed MCLs. Air sampling did not reveal contamination above background levels, and there were no ARARs for air.

The site-specific ARARs, presented in the following documents, were reviewed for any changes, additions, or deletions.

- ROD signed on September 29, 1987 (OU 16 ROD)
- Consent Decree signed on September 6, 1988
- ROD signed on September 26, 1989 (Subunit B/C groundwater and soil)
- Consent Decree signed on November 27, 1990
- ESD #1 signed on January 24, 1991
- Action Memorandum finalized on October 15, 1991 for chromium and cadmium in soils
- Consent Order signed on January 31, 1992 (based on the 1991 Action Memorandum)
- ESD #2 signed on May 5, 1993
- ESD #3 signed on December 22, 1995
- ESD #4 signed on March 26, 1998

The following requirements have been identified as ARARs:

- **Safe Drinking Water Act (SDWA) –** Requires that, upon completion of the remedy, groundwater in Subunits B and C meet the MCLs for TCE (5 µg/L), chromium (100 μg/L) and other contaminants as listed in the 1987 and 1989 RODs and amended in ESDs #2 and #4. Furthermore, all state and federal MCLs in place at the time these decision documents were issued are applicable to the treatment plant effluent.

- **Arizona water law** - Sets cleanup standards for Subunit A at the MCLs because it is part of a "definable aquifer" and has not received an aquifer use exemption that would exempt it from meeting these standards (EPA 1989a).
- **ADEQ Action Levels** - Sets cleanup goals for compounds that did not have MCLs at the time the RODs and ESDs were issued.
- **Resource Conservation and Recovery Act (RCRA)** - Requires that the areas where contaminants were released must meet MCLs. Requires that wastes from the treatment system (such as spent carbon) be properly characterized and disposed of (EPA, 1989b).
- **Maricopa County Air Quality Rules** - Currently limits untreated emissions of VOCs to 3 pounds per day (Maricopa County 2005), although the limitation at the time of the 1989 ROD was 40 pounds per day.

Past and current chemical-specific ARARs are summarized in Table 6-1. The only changes in chemical-specific ARARs resulted from changes in MCLs over the remedial action period, as documented in ESD #1, ESD #2 and ESD #4. While MCLs for several compounds have increased, the MCL for cadmium has decreased from 10 μg/L to 5 μg/L, and the MCL for lead has decreased from 50 μg/L to 15 μg/L. In addition, the MCL for arsenic will be reduced from 50 to 10 μg/L in 2006. Although ARARs for these metals were exceeded during the 1989 RI/FS, they were not identified as primary groundwater contaminants at PGAS and are not currently monitored for on a regular basis. It may be necessary to collect groundwater samples for cadmium, lead and arsenic to ensure that the cleanup standards are being met.

Although the 1987 ROD required air emission controls on the Subunit A groundwater treatment system, emissions from the treatment system have been consistently lower than 1 pound per day, thus the system is still protective despite the removal of air emission controls in 1995. At the time of the 1987 ROD, the Maricopa County Air Quality Rules required emission controls if VOC emissions exceeded 40 pounds per day. The applicable standard has since been lowered to 3 pounds per day. However, because the treatment system is currently emitting less than 1 pound of VOCs per day (lower than the current Maricopa County Air Quality Rule of 3 pounds per day), the remedy is still protective and the ARAR need not be changed.

6.2.2 Institutional Controls

Current Institutional Controls (ICs) were reviewed in Section 5.4.2. Current ICs are insufficient to effectively restrict contact with contaminated media. Although a restriction is in place to prevent human consumption of untreated groundwater at the site, contamination has migrated beyond the property boundaries, where there are no restrictions on use. In addition, there are no restrictions on excavating portions of the site that may contain contaminated soil, such as the former sludge drying beds or the SVE polygon areas. ICs will need to be expanded to ensure long-term protection of human health and the environment.

Table 6-1
Changes in Chemical-Specific ARARs
Phoenix Goodyear Airport (South) Superfund Site
Goodyear, Arizona

Compound	Original Cleanup Level (μg/L)	Revised Cleanup Level (μg/L)	2005 MCL (μg/L)	Source of Cleanup Level
1,1-Dichloroethylene	7	7	7	1989 ROD
1,2-Dichloropropane	1	1	5	1989 ROD
Chloroform	100	100	100	1989 ROD
Toluene	340	1,000	1,000	1998 ESD #4
Trichlorethylene	5	5	5	1989 ROD
Trichlorofluoromethane	1	1	----	1989 ROD
Carbon Tetrachloride	5	5	5	1989 ROD
Methylene Chloride	1	1	5	1989 ROD
Methyl Ethyl Ketone	170	350	----	1991 ESD #1
Xylenes	440	440	10,000	1989 ROD
Antimony	1.46	1.46	6	1989 ROD
Arsenic	50	50	10 (Proposed)	1989 ROD
Barium	1,000	2,000	2,000	1998 ESD #4
Beryllium	0.0039	0.004	4	1998 ESD #4
Cadmium	10	5	5	1998 ESD #4
Chromium	50	100	100	1998 ESD #4
Lead	50	15	15 (Action Level)	1998 ESD #4
Mercury	2	2	2	1989 ROD
Nickel	15.4	100	100	1998 ESD #4
Selenium	10	50	50	1998 ESD #4
Silver	50	50	----	1989 ROD
Zinc	5,000	5,000	----	1989 ROD
Acetone	----	700	----	1991 ESD #1
Benzene	----	5	5	1993 ESD #3
Ethylbenzene	----	700	700	1993 ESD #3
Tetrachloroethylene	----	5	5	1993 ESD #3
1,1,2,2,-Tetrachloroethane	----	0.18	----	1993 ESD #3

Notes:

μg/L = micrograms per liter

---- = Not Established

6.3 Recent Information Affecting the Remedy

Perchlorate has been identified as an emerging contaminant that is known to be present in the area. A component of propellants, perchlorate has not been used at PGAS. Samples were collected by ADEQ on July 13, 1999 from four wells in the area: COG-05, COG-11, E-12 and EMW-10. Perchlorate was not detected in any of these samples above the reporting limit of 4 μg/L. Additional sampling was conducted by LAW Engineering between March 27 and May 3, 2002. Two wells contained perchlorate above the method reporting level of 2 µg/L, EMW-21UC with 4.1 µg/L and EMW-22LC with 5.9 µg/L. The remaining wells, GMW-03, GMW-04, GMW-17UC, EMW-17 and COG-05, did not contain perchlorate above the method reporting limit.

An additional source of contamination in the area is the Western Avenue Plume, an Arizona Water Quality Assurance Revolving Fund site. The Western Avenue Plume consists of low levels of perchloroethene (PCE) in Subunit A, which has migrated westward towards PGAS. Encroachment of the plume has been monitored, and the PCE has entered the Subunit A treatment system. Recent sampling in groundwater monitoring wells indicates that the remaining PCE is below the MCL of 5 µg/L in the vicinity of PGAS, and does not currently affect the remedy. However, evaluation of perchlorate levels in the study area should be continued.

7.0 Issues and Recommendations

Remediation at PGAS is generally proceeding towards cleanup goals as specified in the 1987 ROD, 1989 ROD and other decision documents. The soils at the site have been remediated in general accordance with the decision documents and no further soils remediation has been required by ADEQ or EPA. The groundwater treatment systems have been largely successful in reducing contaminant mass and containing contaminant plumes. The primary issues identified during the 2005 five-year review process include evaluating the extent of trace metals, particularly near the former sludge drying beds; the possibility of ecological risks associated with shallow soil contamination; the lack of data on vapor intrusion into industrial buildings at the site; ensuring capture of the northern Subunit B/C plume; inability to optimize TCE mass removal from groundwater due to chromium concentrations above cleanup levels; encroachment of the Western Avenue PCE plume and PGA North TCE plume; lack of recent Operation and Maintenance Manual updates; and lack of institutional controls. This section discusses each issue and provides recommendations for improvement.

1. Issue

There is a lack of recent data on trace metals other than chromium in groundwater. Metals such as cadmium, lead, arsenic and nickel were identified in the 1989 RI/FS and 1989 ROD as contaminants exceeding ARARs. However, there has been little monitoring for these metals, based on documents obtained as part of the five-year review. It is possible that if these metals are determined to be present in Subunit A, the current remedy will reduce concentrations through redistribution, as is the case with chromium. Compounds listed in Table 3-12 of the 1989 RI/FS that exceeded current MCLs include antimony, arsenic, cadmium, chromium and lead.

Recommendation

Evaluate historical distribution of trace metals and develop a plan to sample any locations that potentially contain trace metals at levels higher than current ARARs.

2. Issue

There has been no confirmation monitoring in the vicinity of the former sludge drying beds. Although geotechnical and chemical tests were performed during the soil stabilization process, there is no post-remedy monitoring data to ensure that the remedy was effective.

Recommendation

Obtain samples from Subunit A groundwater monitor wells in the vicinity of the former sludge drying beds to confirm that there has been no impact to groundwater.

3. Issue

Prior remediation for chromium and cadmium may not be adequately protective of ecological receptors, as there are areas of soil with concentrations of metals above ecological risk levels, but below the human-health-based levels set forth in the 1991 Action Memorandum, which were not excavated as part of the remedial actions. Areas of particular concern include the former chrome sludge drying beds, the airport drainage ditch near Outfall 1, the former sewage treatment plant, former paint tent area and the hangar apron area.

Recommendation

Conduct a screening-level Ecological Risk Assessment to determine whether additional characterization or more detailed risk analysis is necessary.

4. Issue

There has been no assessment of vapor intrusion. There may be areas near buildings that contain residual TCE at levels sufficient to pose a threat to indoor air quality.

Recommendation

Assess concentrations of TCE and other VOCs in shallow soil gas to evaluate potential impact on indoor air quality.

5. Issue

Capture of the northern Subunit B/C plume has not been thoroughly demonstrated. Current understanding of the extent of TCE contamination in the vicinity of E-102, particularly along the northern and western margins, is not confirmed with sentinel wells. E-102 is at the distal end of the northern Subunit B/C plume, with a TCE concentration of 4.9 µg/L in the second half of 2004 (Sharp and Associates, 2005b). Cessation of injection at injection wells and off-site pumping may also impact future plume movement.

Recommendations

1. Evaluate aquifer hydraulic data and contaminant trends to confirm capture of the northern Subunit B/C plume.
2. Expand the monitoring program to extend north and west of the currently delineated plume. Additional monitoring well(s)/sentinel well(s) may be required if there are not already appropriate monitoring points.

6. Issue

Vertical capture of the northern and southern Subunit B/C plumes has not been demonstrated.

Recommendation

Evaluate the vertical capture of the Subunit B/C plumes through the use of aquifer data, gradient calculations, possible installation of monitoring wells, and other appropriate means.

7. Issue

Chromium in Subunit A groundwater is not currently being treated as required by ESD #3. Although the chromium treatment system was shut down in 2001 and approved for removal in 2003 based on treatment plant effluent concentrations, this may need to be reevaluated, as TCE removal cannot be optimized without chromium treatment. One alternative that was evaluated in 1995 was the Lewis carbon system. Although this was more expensive to operate for the short term, it may be less problematic than the affinity chromatograph that was used previously at the site. Also, additional technologies may have been developed since 1995.

Recommendation

1. Evaluate installation of one or more chromium treatment systems for wells that show high concentrations of this metal.

2. If treatment is found to be unnecessary, an Explanation of Significant Difference should be issued to formalize this change from the remedy specified in ESD #3.

8. Issue

Removal of TCE from Subunit A cannot be optimized due to chromium concentrations above the cleanup level.

Recommendation

Optimize the pumping regime for removal of TCE mass, which may require chromium treatment and/or some other technical approach.

9. Issue

The Western Avenue PCE plume has encroached upon the Subunit A TCE plume at the site. Concentrations of PCE are currently below the MCL in groundwater monitoring wells, and it is believed that all contamination migrating onto the PGAS site has been captured by the Subunit A treatment system.

Recommendation

Continue monitoring movement of the Western Avenue PCE plume.

10. Issue

Perchlorate from the PGA North site has been detected in nearby production wells. Although perchlorate is not a contaminant of concern at PGAS, its movement may impact groundwater at PGAS, particularly north of Yuma Road.

Recommendation

Continue monitoring movement of perchlorate from the PGA North site.

11. Issue

There have been several incidents of unexpected maintenance costs at the site, including a leak in the acid tank at the Subunit A treatment facility, a leak in a raw water line for a Subunit A extraction well, and disruption of electrical services in unprotected buried electric lines. In addition, observations were made during the site inspection of rusting wellhead piping, missing locks on well vaults, and missing caps on discharge pipes and sounding tubes, that may lead to additional maintenance costs in the future. Most of these issues are due to the aging of the components of the treatment system. Also, the Operation and Maintenance Plan has not been updated since 1994.

Recommendations

1. Conduct preventative maintenance to reduce unexpected costs and maintain long-term viability of the treatment systems.

2. Update the Operation and Maintenance Plans for the Site.

12. Issue

Current institutional controls may not prevent exposure to contaminated media in the future, particularly as properties change hands. There are no institutional controls currently in place for contaminated soil, including the former sludge drying beds, or for groundwater contamination that has migrated beyond the property boundaries.

Recommendation

Implement additional institutional controls to ensure continued prevention of exposure to contaminated media.

These issues, recommendations and follow-up actions are summarized in Table 7-1.

TABLE 7-1
Summary Table - Issues, Recommendations and Follow-Up Actions
Phoenix Goodyear Airport South Superfund Site
City of Goodyear. Maricopa County. Arizona

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N) Current	Affects Protectiveness (Y/N) Future
1. Lack of trace metal data and effect of lowered MCLs	Evaluate areas with potential metals contamination and collect samples for antimony, arsenic, chromium, cadmium and lead	Goodyear Tire and Rubber Company	ADEQ	Spring 2006	Y	Y
2. Lack of confirmation data for chromium sludge drying beds remedy	Collect Subunit A groundwater samples for chromium, cadmium and lead to confirm that there has been no impact to groundwater	Goodyear Tire and Rubber Company	ADEQ	Spring 2006	Y	Y
3. Residual metals in soil may pose a risk to ecological receptors	Conduct screening-level Ecological Risk Assessment	Goodyear Tire and Rubber Company	ADEQ and EPA	Fall 2006	Y	Y
4. No information exists on vapor intrusion to buildings from VOCs in soil	Evaluate conditions in shallow soil gas to assess whether VOC levels may pose a threat to indoor air quality	Goodyear Tire and Rubber Company	ADEQ	Summer 2006	Y	Y
5. Possible lack of horizontal hydraulic containment of northern Subunit B/C plume	a) Evaluate contaminant concentration trends and hydraulic data. b) Expand monitoring program to the north and west, consider installing at least one sentinel well in an appropriate location(s)	Goodyear Tire and Rubber Company	ADEQ	Summer 2006	Y	Y

TABLE 7-1
Summary Table - Issues, Recommendations and Follow-Up Actions
Phoenix Goodyear Airport South Superfund Site
City of Goodyear, Maricopa County, Arizona

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
6. Possible lack of vertical hydraulic containment of Subunit B/C plumes	Evaluate capture of Subunit B/C plumes through use of aquifer data, gradient calculations, possible installation of monitoring wells and other appropriate means	Goodyear Tire and Rubber Company	ADEQ	Summer 2006	Y	Y
7. Chromium in Subunit A is not being treated as required by ESD #3	a) Evaluate installation of one or more chromium treatment systems b) Issue ESD if chromium treatment is determined to be unnecessary.	a) Goodyear Tire and Rubber Company b) EPA	ADEQ and EPA	Summer 2006	Y	Y
8. Chromium concentrations interfere with optimum TCE extraction from Subunit A	Optimize pumping and treatment regime for maximum TCE removal while meeting chromium effluent standard	Goodyear Tire and Rubber Company	ADEQ	Spring 2007	N	N
9. Western Avenue PCE groundwater plume encroaching on site	Continue monitoring PCE plume movement	ADEQ	ADEQ	Annually	N	N
10. Perchlorate detected in groundwater north of site	Continue monitoring perchlorate concentrations in groundwater	ADEQ	ADEQ	Annually	N	N
11. Unexpected maintenance items and outdated O&M plans	a) Institute preventative maintenance program to reduce maintenance costs b) Update Operation and Maintenance Plans.	Goodyear Tire and Rubber Company	ADEQ	Continually	N	N
12. Institutional controls may not be adequate in the long term	Add institutional controls such as deed use restrictions	ADEQ, ADWR and property owners	ADEQ	Fall 2006	N	Y

8.0 Protectiveness Statement

The remedies at PGAS for groundwater and soil (OUs 1, 2 and 6) are currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled. In order for the remedy to remain protective in the long term, institutional controls may need to be put into place at the site.

9.0 Next Review

The next comprehensive five-year review for PGAS will be conducted on or before September 2010.

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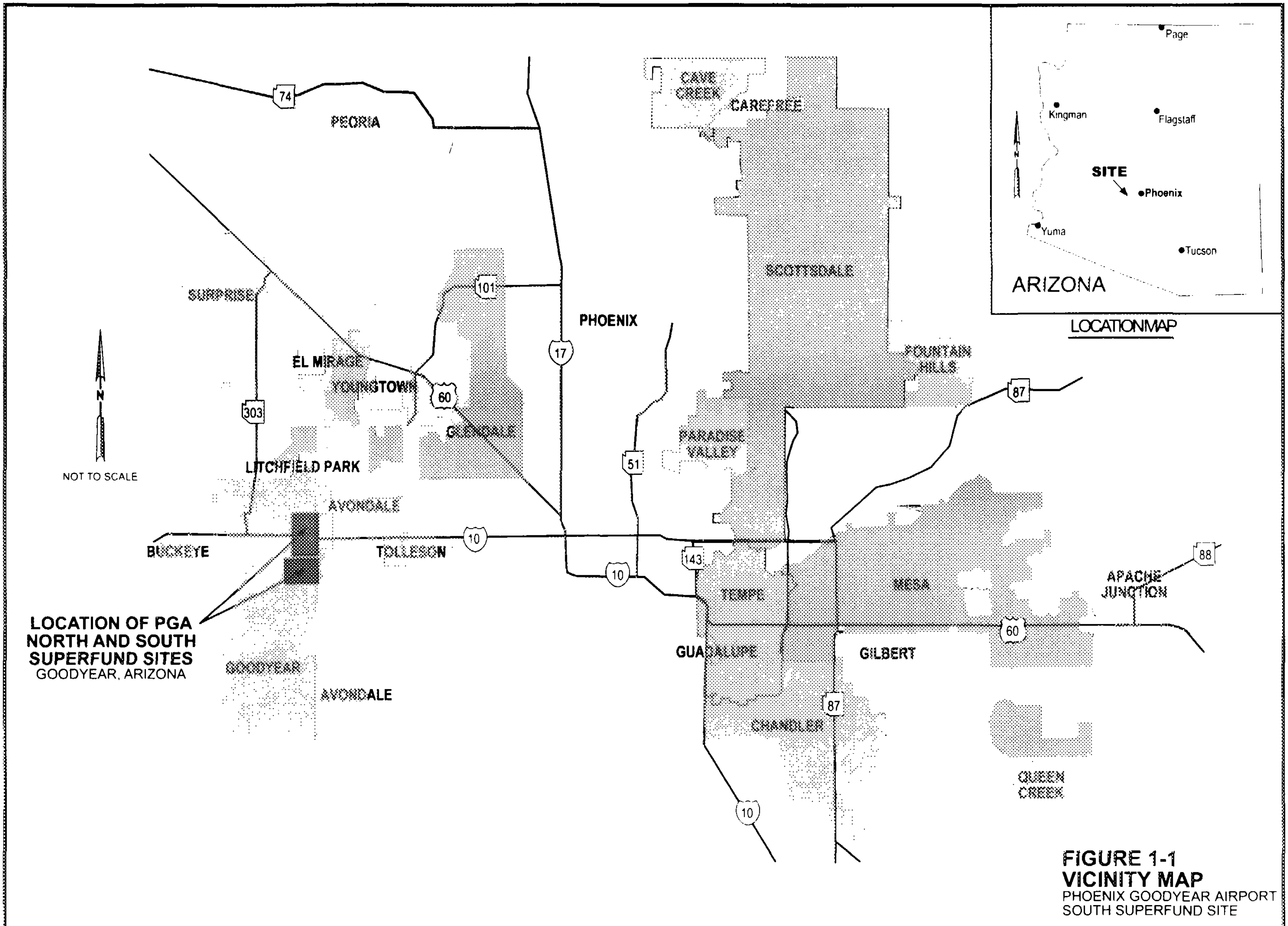

FIGURE 1-1
VICINITY MAP
PHOENIX GOODYEAR AIRPORT
SOUTH SUPERFUND SITE

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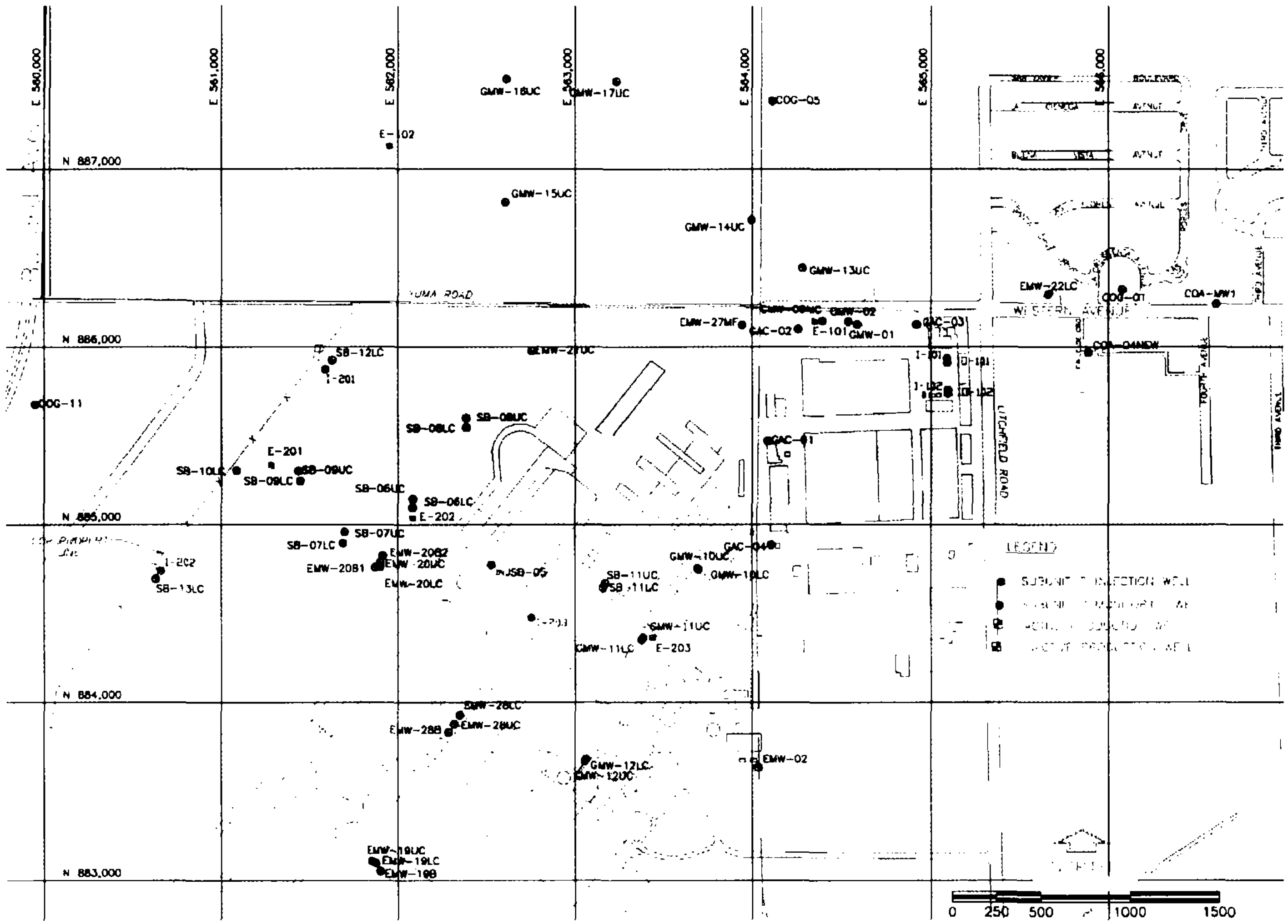

Figure 3-1
Area Map Showing Subunit C Wells
Source: Sharp and Associates 2005c

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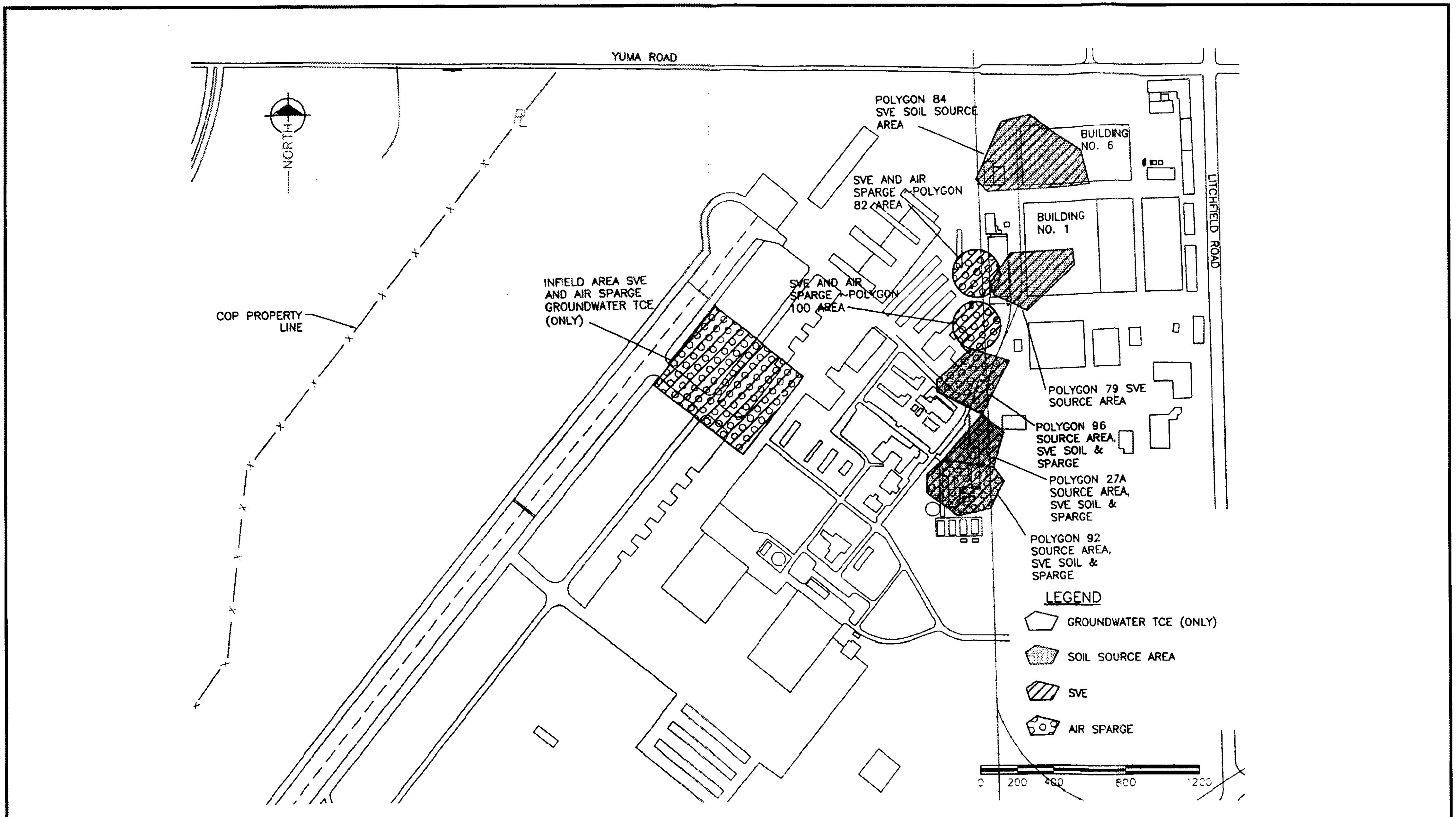

Figure 4-1
Soil Vapor Extraction and Air Sparging Locations
Phoenix Goodyear Airport (South)
Source: Sharp and Associates 2005a

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Figure 4-2
TCE Concentrations in Subunit A, 1990
Source: Sharp and Associates, 1995a

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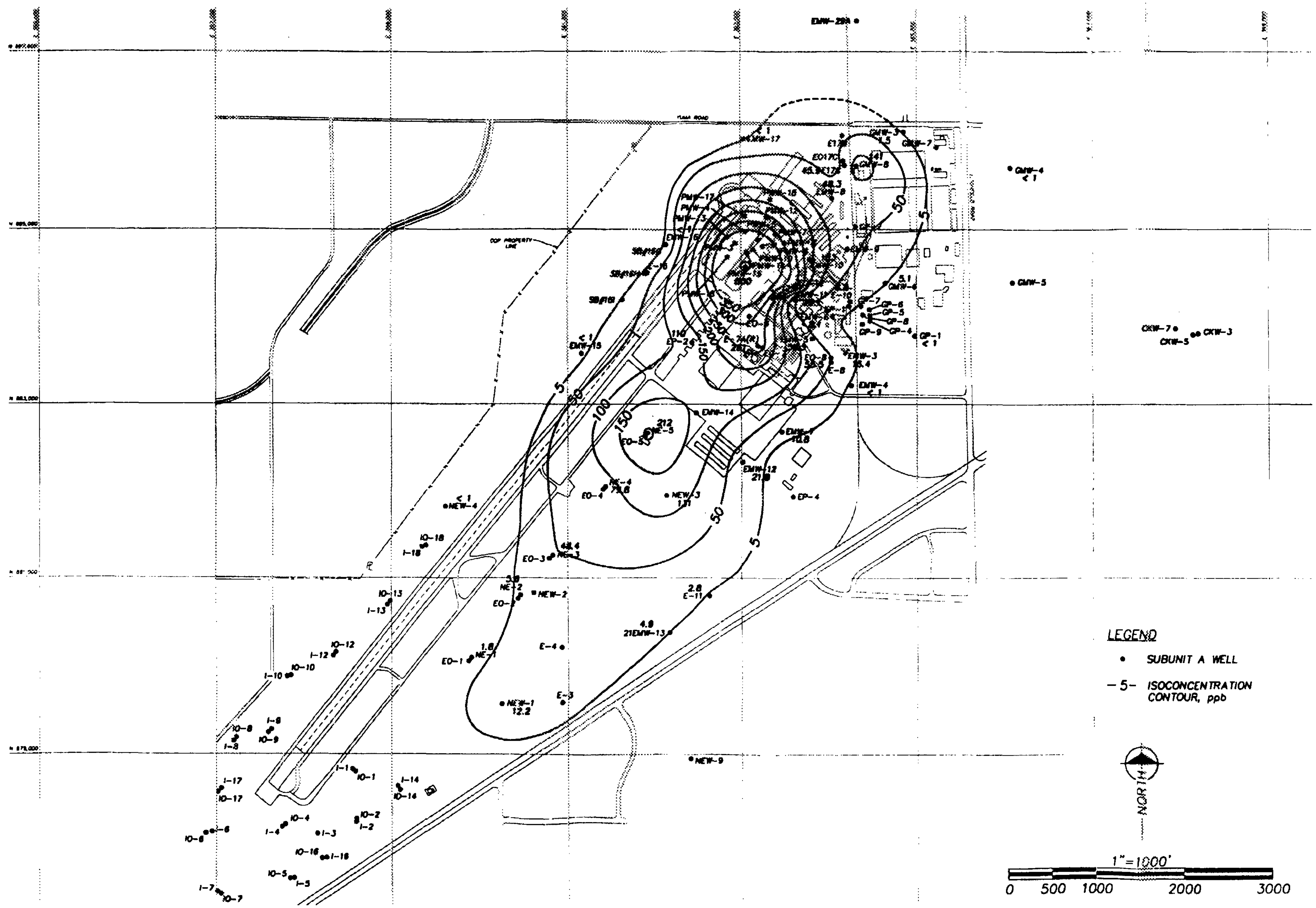

Figure 4-3
TCE Concentrations in Subunit A, May 1998
Phoenix Goodyear Airport (South)
Source: Sharp and Associates 1998

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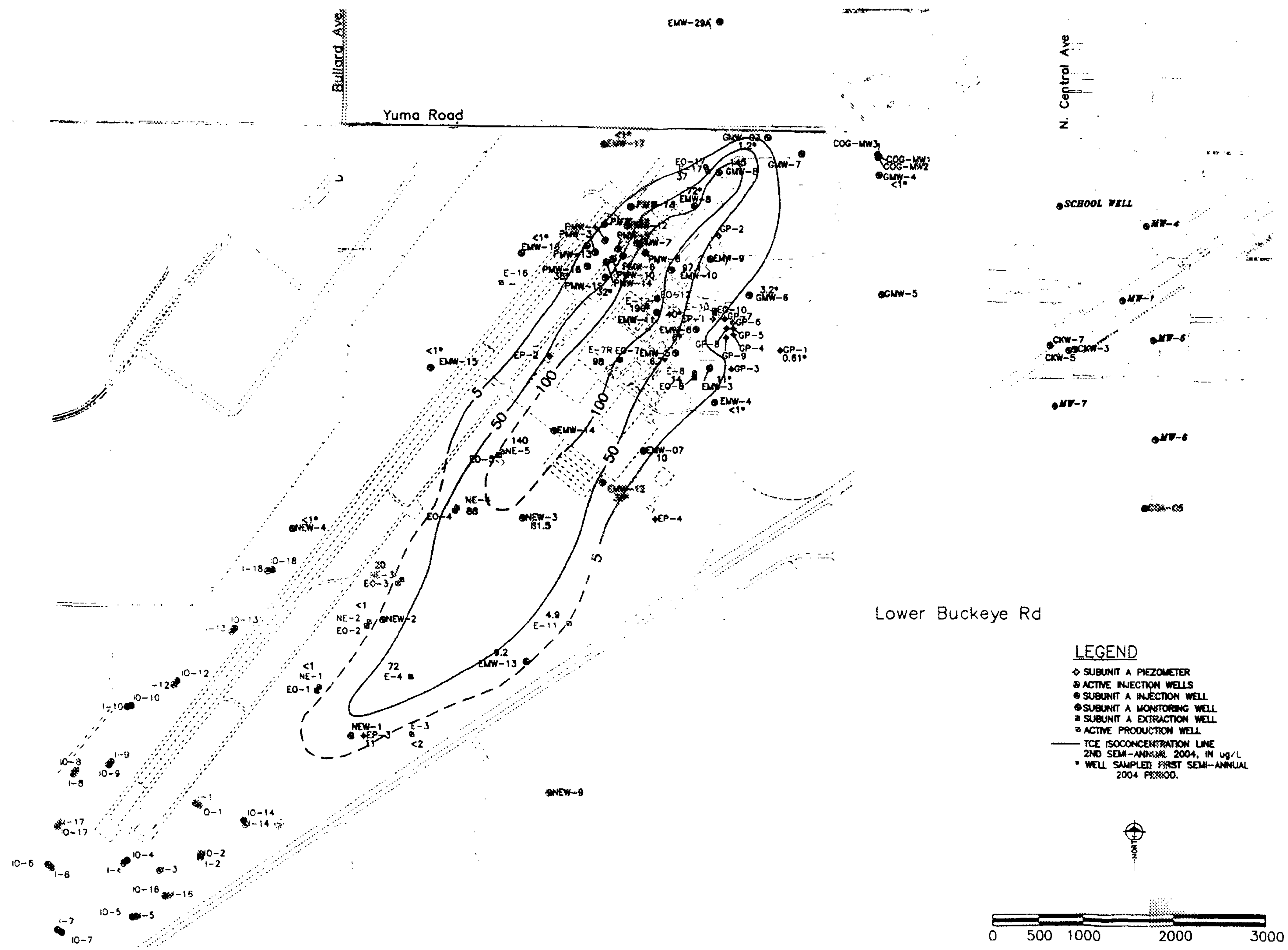

Figure 4-4
TCE Concentrations in Subunit A, 2004
Phoenix Goodyear Airport (South)
Source: Sharp and Associates 1998

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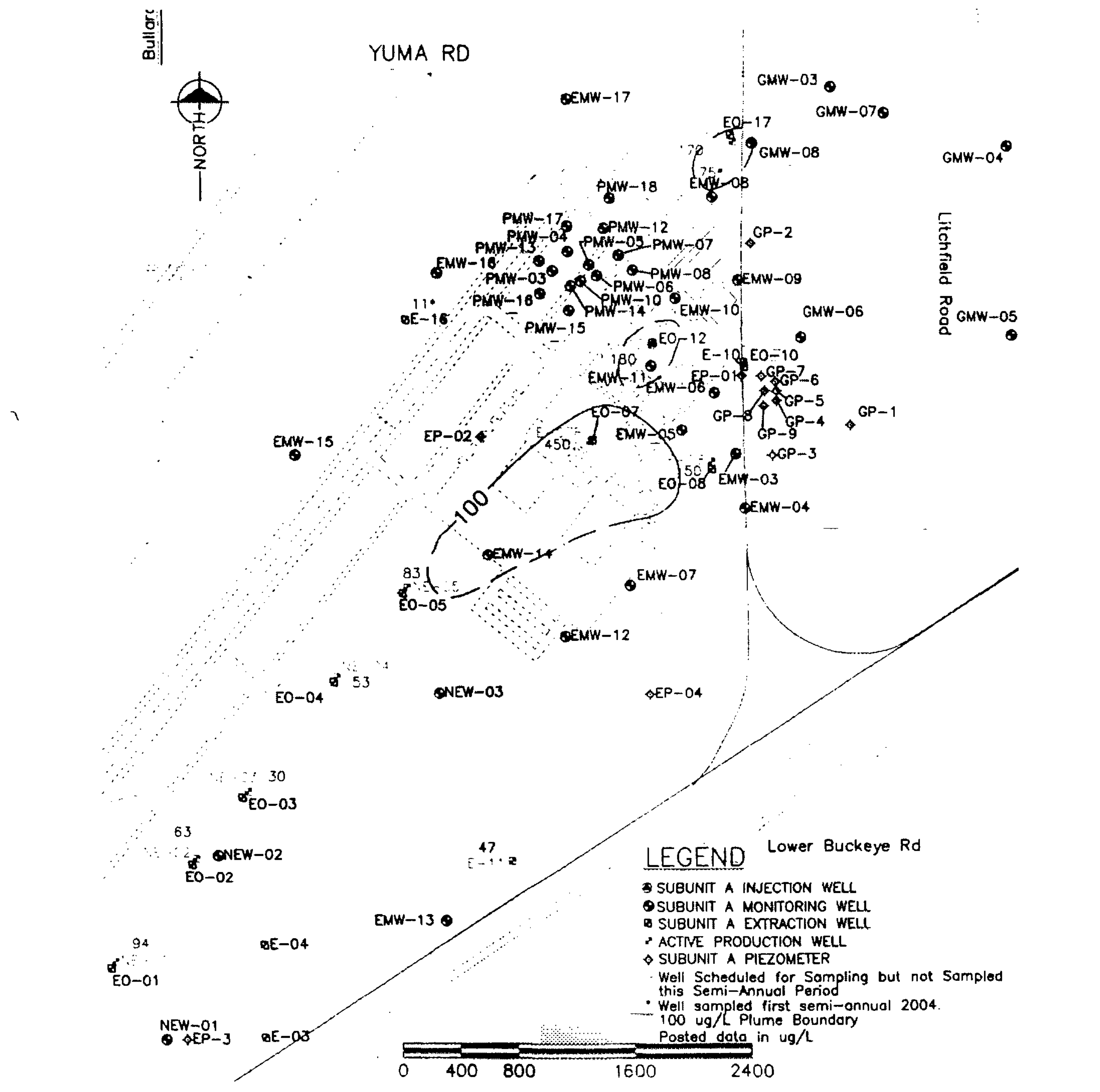

Figure 4-5
Chromium in Subunit A, 2004
Phoenix Goodyear Airport (South)
Source: Sharp and Associates 2005b

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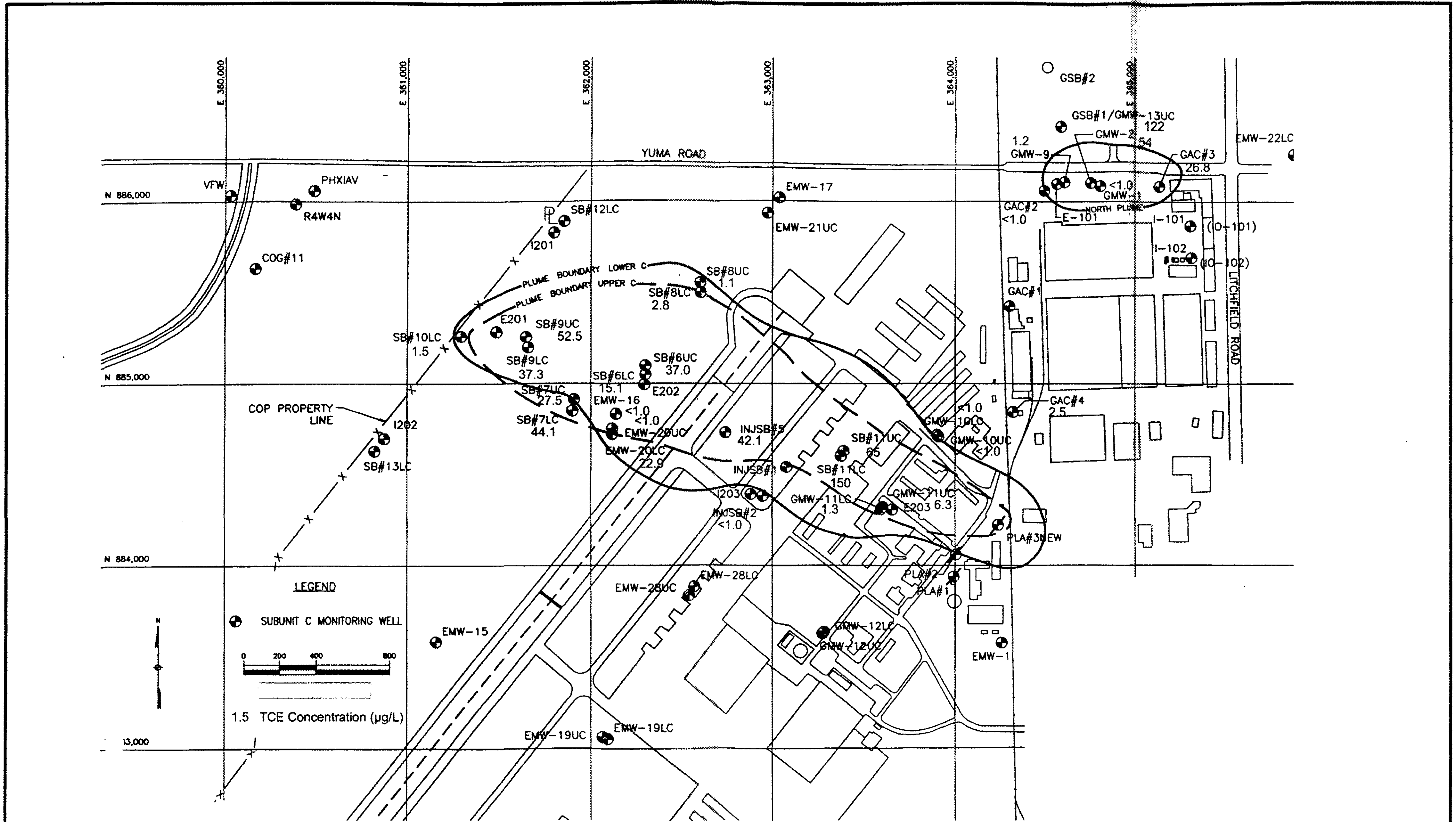

Figure 4-6
TCE Concentrations in Subunit C, 1995
Phoenix Goodyear Airport (South)
Source: Sharp and Associates 1995a, Sharp and Associates 2005b

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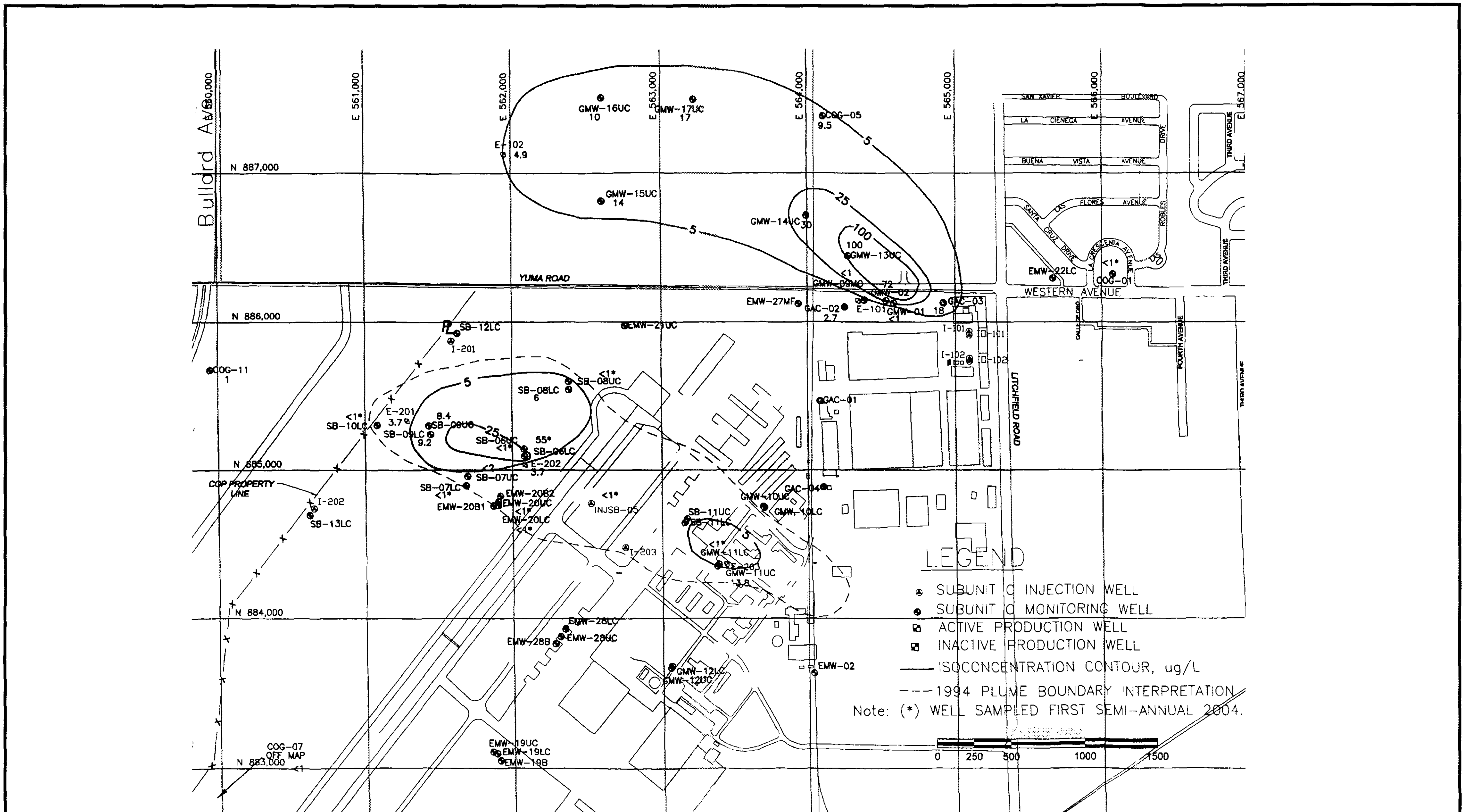

Figure 4-7
TCE Concentrations in Subunit C, 2004
Phoenix Goodyear Airport (South)
Source: Sharp and Associates 2005B

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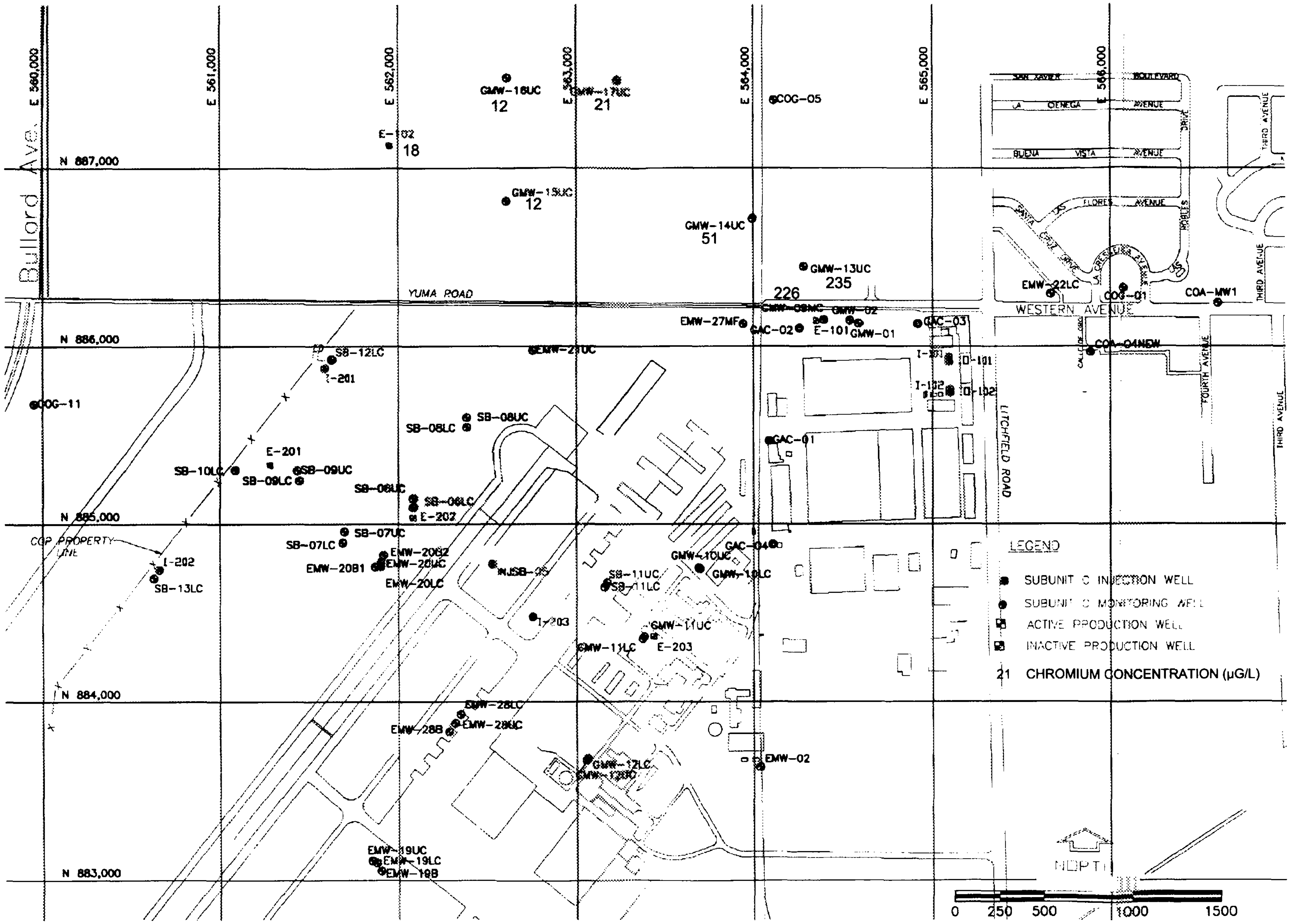

Figure 4-8
Chromium Concentrations in Subunit C, 2004

Source: Sharp and Associates 2005b

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Appendix A
Documents Reviewed

APPENDIX A

Documents Reviewed

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Appendix B
Five-year Review Site Inspection Checklist and Interview Summary Forms

Five-Year Review Site Inspection Checklist
Phoenix-Goodyear Airport (PGA) South Superfund Site

I. SITE INFORMATION	
Site name: PGA South	**Date of inspection:** 4/28/2005
Location and Region: Goodyear, AZ, Region IX	**EPA ID:**
Agency, office, or company leading the five-year review: EPA Region IX	**Weather/temperature:** Cloudy, 70 degrees F

Remedy Includes: (Check all that apply)
- Cover/containment
- Access controls
- Institutional controls
- ✓ Groundwater pump and treatment
- Surface water collection and treatment
- Other (specify)

Attachments: ✓ Inspection team roster attached ✓ Site map attached [in report]

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Jeff Sussman — Project Manager — 4/28/2005
   (Name — Title — Date)

   Interviewed ☒ Phone No (330) 796-0578
   Problems, suggestions; Email: jeffsussman@goodyear.com

   NOTE: All referenced attachments can be found in Five-Year Review Report.

2. **O&M staff** , Richard Bartholomew, David Bartholomew, Field Operations Manager — 4/28/2005
   (Name — Title — Date)

   Interviewed☒ Phone No. .(480) 488-9775
   Problems, suggestions Email: be2@doitnow.com

3. **Local regulatory authorities and responsible agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency Arizona Department of Environmental Quality

Contact			
Nancy Lou Sandoval		5/3/2005	(602) 771-4354
Name	Title	Date	Phone No.

Problems; suggestions

4. **Other interviews** (optional)☒

Agency City of Phoenix

Contact			
Cynthia Parker		5/10/2005	(602) 273-2730
Name	Title	Date	Phone No.

Problems; suggestions

III. ONSITE DOCUMENTS AND RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

O&M manual	✓Readily available	Up to date
As-built drawings	✓Readily available	✓Up to date
Maintenance logs	✓Readily available	✓Up to date

Remarks: O&M Manual in Subunit A control room is dated Jan. 12, 1990.

2. **Site-Specific Health and Safety Plan** ✓Readily available ✓Up to date

Contingency plan/emergency response plan Readily available Up to date

Remarks: Contingency/Emergency Response Plan is 1 section of the Health and Safety plan.

3. **O&M and OSHA Training Records** ✓ Readily available Up to date N/A

Remarks: Training records are kept at the office of Bartholomew Engineering. Operator carries card certifying training.

4. **Permits and Service Agreements**

Air discharge permit	Readily available	Up to date	✓ N/A
Effluent discharge	Readily available	Up to date	N/A
Waste disposal, POTW	Readily available	Up to date	✓ N/A
Other permits ____________	Readily available	Up to date	✓ N/A

Remarks: Poor Quality Groundwater Withdrawal Permit is kept at office of Sharp and Associates.

5.	**Gas Generation Records**	Readily available	Up to date	✓ N/A
	Remarks			
6.	**Settlement Monument Records**	Readily available	Up to date	✓ N/A
	Remarks			
7.	**Groundwater Monitoring Records**	✓ Readily available	Up to date	N/A
	Remarks: Latest report is the second semiannual report for 2004.			
8.	**Leachate Extraction Records**	Readily available	Up to date	✓ N/A
	Remarks			
9.	**Discharge Compliance Records**			
	Air	Readily available	Up to date	✓ N/A
	Water (effluent)	Readily available	Up to date	N/A
	Remarks: Poor Quality Groundwater Withdrawal Permit reporting is conducted by Sharp and Associates.			
10.	**Daily Access/Security Logs**	✓ Readily available	Up to date	
	Remarks Entries are kept in a yellow field book.			

IV. O&M COSTS

1. **O&M Organization**

State in-house — Contractor for State
PRP in-house — ✓ Contractor for PRP
Other

2. **O&M Cost Records**

Readily available — Up to date
Funding mechanism/agreement in place — NA
Original O&M cost estimate________________ Breakdown attached

Total annual cost by year for review period if available

Date	Date	Total cost	
From ______	To ______	______	Breakdown attached
From 1/1/2004	To 12/31/2004	$820,000 (verbal estimate)	Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons:

V. ACCESS AND INSTITUTIONAL CONTROLS ✓ Applicable

A. Fencing

1. **Fencing** ✓ Location shown on site map ✓ Gates secured N/A
   Remarks: Most of the site is within the Phoenix-Goodyear Airport property, owned by the City of Phoenix. The airport is completely fenced with security clearance required for access. Facilities off of the airport property are also fenced, including well E-102 and the Northern Subunit C treatment system.

B. Other Access Restrictions

1. **Signs and other security measures** Location shown on site map N/A
   Remarks: All fenced enclosures have signs stating the system name and ownership information.

C. Institutional Controls

1. **Implementation and enforcement**
   Site conditions imply ICs not properly implemented Yes No ✓ N/A
   Site conditions imply ICs not being fully enforced Yes No ✓ N/A

   Type of monitoring (e.g., self-reporting, drive by)
   Frequency
   Responsible party/agency

   Contact
   Name Title Date Phone No.

   Reporting is up-to-date Yes No ✓ N/A
   Reports are verified by the lead agency Yes No ✓ N/A

   Specific requirements in deed or decision documents have been met ⊠ Yes No N/A
   Violations have been reported Yes No ✓ N/A
   Other problems or suggestions: Report attached

2. **Adequacy** ICs are adequate ICs are inadequate ✓ N/A
   Remarks: There are no institutional controls currently in place.

D. General

1. **Vandalism/trespassing** Location shown on site map No vandalism evident
   Remarks The only reported incident was in 2004, when tools were stolen from the Subunit A treatment facility.

2. **Land use changes onsite** ✓ N/A
   Remarks: The property has been and will likely remain commercial/industrial.

3. **Land use changes offsite** N/A Remarks: Property to the north and west of the site is generally agricultural and will likely be developed for commercial/industrial uses.			

VI. GENERAL SITE CONDITIONS

A. Roads Applicable

1. **Roads** Location shown on site map Roads adequate N/A
   Remarks: Paved roads are in good condition. Many wells are in open areas and not accessible by roads.

B. Other Site Conditions

Remarks

VII. LANDFILL COVERS ✓ Not Applicable

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
   Areal extent________ Depth
   Remarks

2. **Cracks** Location shown on site map Cracking not evident
   Lengths ________ **Widths**________ Depth
   Remarks

3. **Erosion** Location shown on site map Erosion not evident
   Areal extent________ Depth
   Remarks

4. **Holes** Location shown on site map Holes not evident
   Areal extent________ Depth
   Remarks

5. **Vegetative Cover** Grass Cover properly established No signs of stress
   Trees/Shrubs (indicate size and locations on a diagram)
   Remarks ________

6. **Alternative Cover** (armored rock, concrete, etc.) N/A Remarks			
7. **Bulges** Areal extent________________ Remarks	Location shown on site map **Height**	Bulges not evident	
8. **Wet Area/Water Damage** Wet areas Ponding Seeps Soft subgrade Remarks	Wet areas/water damage not evident Location shown on site map Location shown on site map Location shown on site map Location shown on site map	 Areal extent Areal extent Areal extent Areal extent	
9. **Slope Instability** Slides Areal extent Remarks	Location shown on site map	No evidence of slope instability	
B. Benches Applicable N/A (Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)			
1. **Flows Bypass Bench** Remarks	Location shown on site map	N/A or okay	
2. **Bench Breached** Remarks	Location shown on site map	N/A or okay	
3. Bench Overtopped Remarks	Location shown on site map	N/A or okay	
C. Letdown Channels Applicable N/A (Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)			
1. **Settlement** Areal extent________________ Remarks	Location shown on site map Depth	No evidence of settlement	

2.	**Material Degradation** Location shown on site map No evidence of degradation Material type_______________ Areal extent Remarks	
3.	**Erosion** Location shown on site map No evidence of erosion Areal extent_______________ Depth Remarks____	
4.	**Undercutting** Location shown on site map No evidence of undercutting Areal extent_______________ Depth Remarks	
5.	**Obstruction** Type_______________ No obstruction Location shown on site map Areal extent Size Remarks	
6.	**Excessive Vegetative Growth** Type No evidence of excessive growth Vegetation in channels does not obstruct flow Location shown on site map Areal extent Remarks	
D. Cover Penetrations	Applicable	N/A
1.	**Gas Vents** Active Passive Properly secured/located Functioning Routinely sampled Good condition Evidence of leakage at penetration Remarks	
2.	**Gas Monitoring Probes** Properly secured/located Functioning Routinely sampled Good condition Evidence of leakage at penetration Remarks	
3.	**Monitoring Wells** (within surface area of landfill) Properly secured/located Functioning Routinely sampled Good condition Evidence of leakage at penetration Remarks	

4.	**Leachate Extraction Wells** Properly secured/located Functioning Routinely sampled Good condition Evidence of leakage at penetration Needs O&M N/A Remarks
5.	**Settlement Monuments** Located Routinely surveyed N/A Remarks
E. Gas Collection and Treatment	Applicable N/A
1.	**Gas Treatment Facilities** Flaring Thermal destruction Collection for reuse Good condition Needs O&M Remarks
2.	**Gas Collection Wells, Manifolds and Piping** Good condition Needs O&M Remarks
3.	**Gas Treatment Facilities** (e.g., gas monitoring of adjacent homes or buildings) Good condition Needs O&M N/A Remarks
F. Cover Drainage Layer	Applicable N/A
1.	**Outlet Pipes Inspected** Functioning N/A Remarks
2.	**Outlet Rock Inspected** Functioning N/A Remarks
G. Detention/Sedimentation Ponds	Applicable N/A
1.	**Siltation**Areal extent_________________ Depth_________________ N/A Siltation not evident Remarks
2.	**Erosion** Areal extent_________________ Depth Erosion not evident Remarks
3.	**Outlet Works** Functioning N/A Remarks

4.	**Dam** Remarks	Functioning	N/A
H. Retaining Walls	Applicable	N/A	
1.	**Deformations** Horizontal displacement____________________ Rotational displacement____________________ Remarks	Location shown on site map	Deformation not evident Vertical displacement
2.	Degradation Remarks	Location shown on site map	Degradation not evident
I. Perimeter Ditches/Off-Site Discharge	Applicable	N/A	
1.	**Siltation** Areal extent________________ **Depth** Remarks	Location shown on site map	Siltation not evident
2.	**Vegetative Growth** Areal extent________________ **Type** Remarks	Location shown on site map Vegetation does not impede flow	N/A
3.	**Erosion** Areal extent________________ **Depth** Remarks	Location shown on site map	Erosion not evident
4.	**Discharge Structure** Remarks	Functioning	N/A

VIII. VERTICAL BARRIER WALLS ✓ Not Applicable	
1.	**Settlement** Location shown on site map Settlement not evident Areal extent__________ Depth Remarks
2.	**Performance Monitoring** Type of monitoring Performance not monitored Frequency__________ Evidence of breaching Head differential Remarks

IX. GROUNDWATER/SURFACE WATER REMEDIES ✓ Applicable	
A. Groundwater Extraction Wells, Pumps, and Pipelines ✓ Applicable	
1.	**Pumps, Wellhead Plumbing, and Electrical** Good condition All required wells located ✓ Needs O&M N/A Remarks: Many of the original extraction wells have wellhead plumbing that is rusting and may need replacing if operation is to continue. Packers for turbine pumps at E-102 and E-201 were leaking, with E-102 having an area of wet soil around the base of the pump.
2.	**Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ✓ Good condition Needs O&M Remarks The pipeline is 4" schedule 40 PVC in good condition.
3.	**Spare Parts and Equipment** ✓ Readily available ✓ Good condition Requires upgrade Needs to be provided Remarks
B. Surface Water Collection Structures, Pumps, and Pipelines Applicable	
1.	**Collection Structures, Pumps, and Electrical** Good condition Needs O&M Remarks
2.	**Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** Good condition Needs O&M Remarks
3.	**Spare Parts and Equipment** Readily available Good condition Requires upgrade Needs to be provided Remarks

C. Treatment System ✓ Applicable

1a. **Subunit A Treatment Train** (Check components that apply)

Metals removal Oil/water separation Bioremediation
✓Air stripping Carbon adsorbers
Filters
✓ Additive (e.g., chelation agent, flocculent)
✓ Good condition Needs O&M
Sampling ports properly marked and functional
✓ Sampling/maintenance log displayed and up to date
Equipment properly identified
Quantity of groundwater treated annually: 260 million gallons
Quantity of surface water treated annually
Remarks: The air stripping system appears to be in good condition. Acid is added to reduce scaling in the tower and injection wells. At the time of inspection, the pH adjustment system was operating incorrectly. Sampling ports and process flow pipes are not labeled. Sampling information and maintenance log are kept in a 3-ring binder.

1b. **Southern Subunit C Treatment Train** (Check components that apply)

Metals removal Oil/water separation Bioremediation
Air stripping ✓Carbon adsorbers
✓Filters
Additive (e.g., chelation agent, flocculent)
✓Good condition Needs O&M
Sampling ports properly marked and functional
Sampling/maintenance log displayed and up to date
Equipment properly identified
Quantity of groundwater treated annually 250 million gallons
Quantity of surface water treated annually
Remarks: The system appears to be in good condition. Sampling ports and GAC tanks are not labeled, although process flow is labeled.

1c. **Northern Subunit C Treatment Train** (Check components that apply)

Metals removal Oil/water separation Bioremediation
Air stripping ✓ Carbon adsorbers
Filters
Additive (e.g., chelation agent, flocculent)
✓ Good condition Needs O&M
Sampling ports properly marked and functional
Sampling/maintenance log displayed and up to date
Equipment properly identified
Quantity of groundwater treated annually 2,000 gallons
Quantity of surface water treated annually
Remarks The system appears to be in good condition. Sampling ports and GAC tanks are not labeled, although process flow is labeled. System is only operated once per month for sampling purposes.

2. **Electrical Enclosures and Panels** (properly rated and functional)

N/A ✓Good condition Needs O&M
Remarks

3. **Tanks, Vaults, Storage Vessels** N/A Remarks: The acid tank at the Subunit A treatment facility is rusted but intact. This tank has failed within the last year and was repaired.
4. **Discharge Structure and Appurtenances** ✓Good condition Needs O&M Remarks: Piping to injection wells is in good condition. Subunit C injection wells tend to have issues with scaling. E-202 was offline during inspection due to limited injection capacity. I-202 was also offline and awaiting rehabilitation.
5. **Treatment Building(s) – support building** N/A ✓ Good condition (especially roof and doorways) Needs repair ✓ Chemicals and equipment properly stored Remarks Acid tank is on a secondary containment sump.
6. Monitoring Wells (pump and treatment remedy) ✓Properly secured/locked ✓ Functioning ✓Routinely sampled ✓Good condition All required wells located Needs O&M N/A Remarks: Some wells on the airport property lack locks and/or caps on sounding tubes and discharge pipes. Wells are generally in good condition and presumed operational, although none were tested during the inspection.

D. Monitored Natural Attenuation
1. **Monitoring Wells** (natural attenuation remedy) Properly secured/locked Functioning Routinely sampled Good condition All required wells located Needs O&M Remarks

X. OTHER REMEDIES
If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). The remedy was put in place to reduce contaminant concentrations to below cleanup levels specified in the ROD. The remedy appears to be effective for VOCs, as VOC concentrations in both soil and groundwater have been reduced during remedial operations. However, chromium in Subunit A was not addressed in the ROD, and it is not clear whether chromium concentrations are being reduced at the site, as there is no treatment for this compound in place.
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. Treatment systems are well-maintained, although some are showing signs of age. Extraction wells in particular will need to be upgraded if operation is to continue.
C.	**Early Indicators of Potential Remedy Failure**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. None.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

<table>
<tr><td colspan="3">Five-Year Review Interview Record</td><td colspan="3">Interviewee: Jeff Sussman, Goodyear Tire and Rubber Company</td></tr>
<tr><td colspan="2">Site Name</td><td colspan="2">EPA ID No.</td><td>Date of Interview</td><td>Interview Method via</td></tr>
<tr><td colspan="2">Phoenix-Goodyear Airport (PGA) South</td><td colspan="2">AZD980695902</td><td>4/28/2005</td><td>Phone ☐
Fax/email ☐
In person ✓</td></tr>
<tr><td>Interview Contacts</td><td>Organization</td><td>Phone</td><td>Email</td><td colspan="2">Address</td></tr>
<tr><td>Mary Aycock</td><td>US EPA Region 9</td><td>(415) 972-3289</td><td>Aycock.Mary@epa.gov</td><td colspan="2">75 Hawthorne Street
San Francisco, CA 94105</td></tr>
<tr><td>Rick Edwards</td><td>CH2M HILL/PHX, as rep of EPA</td><td>(480) 377-6231</td><td>Eedwards@ch2m.com</td><td colspan="2">2625 S. Plaza Drive, Suite 300,
Tempe, AZ 85282</td></tr>
<tr><td colspan="6">Interview Questions</td></tr>
<tr><td colspan="6">1. What is your current role as it relates to the site? What is your overall impression of the work conducted at the site to date? (general sentiment)
Response:
Mr. Sussman is the Project Manager for the Responsible Party (RP - Goodyear Tire and Rubber Company [GTRC]) at the site. The remedy is effective, and the treatment systems have been maintained since inception, although they are showing signs of age. The Subunit C systems are being modernized. Contaminant removal from Subunit A has reached an asymptote, and will take a very long time to reach cleanup levels in the ROD. GTRC has good working relationships with regulatory agencies and other stakeholders.</td></tr>
<tr><td colspan="6">2. What is the current status of construction? Have any problems or difficulties been encountered that have impacted construction progress or implementability?
Response:

Construction is complete. There are no plans for expansion.</td></tr>
<tr><td colspan="6">3. Have there been routine communications or activities (site visits, inspections, reporting activities, etc) conducted by your office regarding the site? If so please give purpose and results.
Response:
Mr. Sussman is on site at least quarterly, typically 7 or more times per year, for construction meetings, community meetings and site visits. He is in almost daily communication with Sharp and Associates and Bartholomew Engineering. Semi-annual reports are submitted by Sharp and Associates for quarterly sampling. Progress updates are given monthly.</td></tr>
</table>

4. What does the monitoring data show? Are there any trends that show contaminant levels are decreasing? Have any new or emerging COCs been identified? If so, have they impacted the effectiveness of the remedy? **Response:** Subunit A – There has been good progress at decreasing plume concentration. Subunit C – There has been good progress in the southern area, while in the northern area, treatment has just started to target the leading edge of the plume north of Yuma Road. Chromium has decreased and continues to decrease despite lack of treatment. PCE has migrated towards the site from the Western Avenue plume.
5. Is there a continuous on-site O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities. **Response:** No. Bartholomew and Associates is on site twice a week for scheduled O&M. This is an average frequency and includes plant operations and groundwater sampling. Plant operations are also monitored remotely Monday through Friday, and alarms can be responded to 24 hours a day, 7 days a week. Bartholomew also does non-recurring maintenance such as well rehabilitation.
6. Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details. **Response:** Yes. An acid-addition system was added to the Subunit A treatment system after construction to treat hard water scaling. Offgases from the air stripper were treated with a GAC unit for some time after construction. Direct burial of electric lines has resulted in some minor incidents due to damage from rodents. The acid tank leaked in 2004 and required repair. A raw water line leaked in 2004 and required repair.
7. Would you say that O&M and/or sampling efforts have been optimized? Please describe how improved efficiency has or has not occurred. **Response:** Yes. There has been continuous improvement to be cost-effective and efficient. The northern Subunit C treatment system has been removed from service, and the number of monitor wells has been reduced.
8. Are you aware of any institutional controls, site access controls, new ordinances in place, changes in actual or projected land use, complaints being filed or unusual activities at the site? If so, please describe in detail. **Response:** No. Agricultural land in the area will be converted to industrial/commercial use.

9. Have any problems been encountered which required, or will require changes to this remedial design or ROD? **Response:** Yes. There have been four Explanation of Significant Differences (ESDs) which reset the cleanup levels. Currently, TCE removal from Subunit A has reached an asymptote.
10. Do you have any comments, suggestions, or recommendations regarding the site? **Response:** Use a risk-based cleanup level rather than MCLs for Subunit A. It is not used for drinking water and cleanup to MCLs will take a long time to achieve.

<table>
<tr><td colspan="3">Five-Year Review Interview Record</td><td colspan="3">Interviewee: David and Richard Bartholomew. Bartholomew Engineering, Inc.</td></tr>
<tr><td colspan="2">Site Name</td><td colspan="2">EPA ID No.</td><td>Date of Interview</td><td>Interview Method via</td></tr>
<tr><td colspan="2">Phoenix-Goodyear Airport (PGA) South</td><td colspan="2">AZD980695902</td><td>4/28/2005</td><td>Phone ☐
Fax/email ☐
In person ✓</td></tr>
<tr><td>Interview Contacts</td><td>Organization</td><td>Phone</td><td>Email</td><td colspan="2">Address</td></tr>
<tr><td>Mary Aycock</td><td>US EPA Region 9</td><td>(415) 972-3289</td><td>Aycock.Mary@epa.gov</td><td colspan="2">75 Hawthorne Street
San Francisco, CA 94105</td></tr>
<tr><td>Rick Edwards</td><td>CH2M HILL/PHX, as rep of EPA</td><td>(480) 377-6231</td><td>Eedwards@ch2m.com</td><td colspan="2">2625 S. Plaza Drive, Suite 300,
Tempe, AZ 85282</td></tr>
</table>

Interview Questions

1. **What is your current role as it relates to the site? What is your overall impression of the work conducted at the site to date? (general sentiment)**

Response:
Perform operation and maintenance, emergency repairs, construction oversight and groundwater sampling on behalf of Goodyear Tire and Rubber Company, through contract with Sharp and Associates. The work is adequate.

2. **What is the current status of construction? Have any problems or difficulties been encountered that have impacted construction progress or implementability?**
   Response:

Construction is complete. There have been no problems.

3. **Have there been routine communications or activities (site visits, inspections, reporting activities, etc) conducted by your office regarding the site? If so please give purpose and results.**

Response:
Yes. Activities include continuing operations, repairs, maintenance. Communications include maintenance log, reporting operations, emergencies and system downtime to Sharp and Associates.

4. **What does the monitoring data show? Are there any trends that show contaminant levels are decreasing? Have any new or emerging COCs been identified? If so, have they impacted the effectiveness of the remedy?**

Response:
TCE is declining (or stabilizing) in all treatment systems. Chromium is also steady or diminishing. There are no new COCs.

5. **Is there a continuous on-site O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.**

Response:
Yes. Staff conducts routine onsite visits at least once per week. Immediate response to alarms is possible 24 hours a day. System is monitored remotely on a daily basis.

6. **Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.**

Response:
System alarms that require immediate attention, mechanical failure, pump problems, leak in pipeline.

7. **Would you say that O&M and/or sampling efforts have been optimized? Please describe how improved efficiency has or has not occurred.**

Response:
Definitely. The recently installed RSView control system has made operation more efficient. Extraction well flow rates have been optimized considering drawdown and other well characteristics and chromium blending.

8. **Are you aware of any institutional controls, site access controls, new ordinances in**

place, changes in actual or projected land use, complaints being filed or unusual activities at the site? If so, please describe in detail. **Response:** No.
9. Have any problems been encountered which required, or will require changes to this remedial design or ROD? **Response:** No.
10. Do you have any comments, suggestions, or recommendations regarding the site? **Response:** Recommend shutting down the Subunit A treatment system and going to Monitored Natural Attenuation.

Five-Year Review Interview Record			**Interviewee:** Cynthia Parker/City of Phoenix		
Site Name		**EPA ID No.**		**Date of Interview**	**Interview Method via**
Phoenix-Goodyear Airport (PGA) South		AZD980695902		5/10/2005	Phone ✓ Fax/email ☐ In person ☐
Interview Contacts	**Organization**	**Phone**	**Email**	**Address**	
Mary Aycock	US EPA Region 9	(415) 972-3289	Aycock.Mary@epa.gov	75 Hawthorne Street San Francisco, CA 94105	
Rick Edwards	CH2M HILL/PHX, as rep of EPA	(480) 377-6231	Eedwards@ch2m.com	2625 S. Plaza Drive, Suite 300, Tempe, AZ 85282	

Interview Questions

1. **What is your current role as it relates to the site? What is your overall impression of the work conducted at the site to date? (general sentiment)**

Response:
Co-Project Manager (along with COP office of Environmental Programs) for an infield LUST site (also used by the Navy). City of Phoenix owns the airport facility, receives communication from the Goodyear Tire and Rubber Company (GTRC) and U.S. Environmental Protection Agency (EPA), and coordinates site access for GTRC.
Cleanup appears to be going well. GTRC is easy to work with. In hindsight, the initial Site Characterization could have been more accurate.

2. **What is the current status of construction? Have any problems or difficulties been encountered that have impacted construction progress or implementability?**
Response:

Construction by City of Phoenix does affect GTRC remedial activities. City of Phoenix has had to work with GTRC to preserve wells during infield paving, and has required GTRC to fix direct-burial electric lines, etc.

3. **Have there been routine communications or activities (site visits, inspections, reporting activities, etc) conducted by your office regarding the site? If so please give purpose and results.**

Response:
GTRC gives status updates to City of Phoenix on approximate semi-annual basis. Airport personnel have almost daily interaction with Bartholomew Engineering at the site. Also receives copies of monthly status reports from GTRC to EPA.

4. What does the monitoring data show? Are there any trends that show contaminant levels are decreasing? Have any new or emerging COCs been identified? If so, have they impacted the effectiveness of the remedy?

Response:

Yes, contaminant levels are decreasing. The chromium treatment system is not operating, so water is blended to achieve regulatory levels for discharge.

There is a WQARF plume ("Western Avenue Plume") encroaching on the site.

Air sparging was an effective additional treatment for the site.

5. Is there a continuous on-site O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

Response:

Bartholomew Engineering is on site several times a week.

City of Phoenix has performed some maintenance, vault replacement and pipeline re-routing as part of their infield paving project.

6. Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.

Response:

Acid release from the GTRC storage tank was unexpected. City of Phoenix personnel found the acid in the secondary containment and notified Bartholomew Engineering, who responded quickly to remedy the situation.

Also, direct-burial electric lines were broken during road construction and had to be fixed.

7. Would you say that O&M and/or sampling efforts have been optimized? Please describe how improved efficiency has or has not occurred.

Response:

Yes. GTRC is always looking to reduce the time required for the remedy, such as the air sparging program.

8. Are you aware of any institutional controls, site access controls, new ordinances in

place, changes in actual or projected land use, complaints being filed or unusual activities at the site? If so, please describe in detail.

Response:

Institutional controls – Original settlement between GTRC and City of Phoenix required that City of Phoenix shut down production wells in the area, and cannot install new production wells.

Site access – Access to the airport property is restricted.

New ordinances - City codes are revised from time to time, but do not appear to have impacted GTRC operations.

Land use – A new master plan for the airport will be forthcoming in 1-2 years. This will deal with only the airport property; City of Goodyear would know more about the surrounding land. Conflicts between the Master Plan and the treatment system are unknown at this time.

Complaints or unusual activities: I received a call from the Emergency Response Unit of EPA about the acid release, after Goodyear Tire called it in to them.

9. Have any problems been encountered which required, or will require changes to this remedial design or ROD?

Response:

GTRC has contemplated requesting a revised remediation standard for the site. The City would have an opinion on this issue, and the new plume ('Western Avenue Plume') on the east side of the airport would be a factor.

10. Do you have any comments, suggestions, or recommendations regarding the site?

Response:

GTRC is easy to work with and is doing the right thing. The treatment seems to be working. If alternate concentration limits are requested, there would have to be an agreement on institutional controls between GTRC and the City of Phoenix.

Five-Year Review Interview Record					Interviewee: Nancy Lou Sandoval/Arizona Department of Environmental Quality (ADEQ)	
Site Name		**EPA ID No.**			**Date of Interview**	**Interview Method via**
Phoenix-Goodyear Airport (PGA) South		AZD980695902			5/3/2005	Phone ✓ Fax/email ☐ In person ☐
Interview Contacts	**Organization**	**Phone**	**Email**	**Address**		
Mary Aycock	US EPA Region 9	(415) 972-3289	Aycock.Mary@epa.gov	75 Hawthorne Street San Francisco, CA 94105		
Rick Edwards	CH2M HILL/PHX, as rep of EPA	(480) 377-6231	Eedwards@ch2m.com	2625 S. Plaza Drive, Suite 300, Tempe, AZ 85282		

Interview Questions

1. What is your relationship to the site? What is your overall impression of the work conducted at the site to date? (general sentiment)

Response:

Ms. Sandoval is the ADEQ Project Manager for the site. The responsible party (RP), Goodyear Tire and Rubber Company, and their consultant Sharp and Associates, does well and is proactive in site activities.

2. Do you feel well informed about the site's activities and progress?

Response:

Yes. Sharp and Associates is good about keeping the agency informed, including monthly progress reports and quarterly tracking logs.

3. Have there been routine communications or activities (site visits, inspections, reporting activities, etc) conducted by your office regarding the site? If so please give purpose and results.

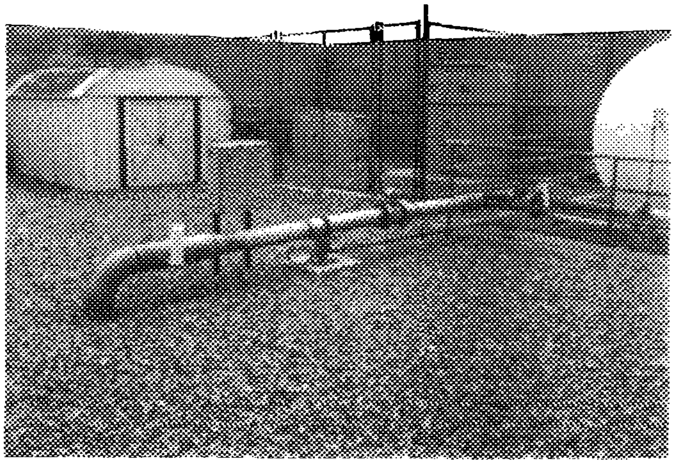
Response:

Yes. Site visits typically once per year or when there is a change in personnel. Also recently took a drive around the site to determine land development in the area. Receives annual, semiannual, quarterly and monthly reports from Sharp and Associates. Has not done a RCRA-type site inspection.

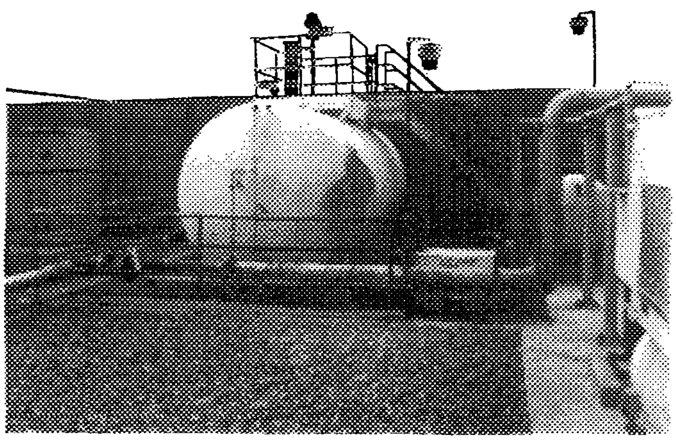
4. Is the remedy functioning as expected? How well is the remedy performing? **Response:** Yes. The pump and treat systems are performing well. The southern Subunit C plume has been reduced in size by more than half, and is no longer encroaching upon COG-11. Subunit A treatment system did experience a lapse in hydraulic capture. Subunit A treatment system cannot pump as much as it could because of chromium concentrations. System is currently 15 years into operation.
5. What does the monitoring data show? Are there any trends that show contaminant levels are decreasing? Have any new or emerging COCs been identified? If so, have they impacted the effectiveness of the remedy? **Response:** VOCs are decreasing in all plumes. Chromium is not decreasing as fast as it did during operation of the treatment unit between 1998 and 2000. There are no new COCs, but chromium is impacting the effectiveness of the remedy because extracted water must be blended so that the treatment plant effluent meets the standard of 100 ppb.
6. Are you aware of any institutional controls, site access controls, new ordinances in place, changes in actual or projected land use, complaints being filed or unusual activities at the site? If so, please describe in detail. **Response:** No. Airport maintains security, and the surrounding land is zoned industrial/commercial.
7. Would you say that O&M and/or sampling efforts have been optimized? Please describe how improved efficiency has or has not occurred. **Response:** Yes. There have been instances of reduced monitoring approved by the agency (ADEQ).
8. Are you aware of any ongoing community concerns regarding the site or its administration? **Response:** The community wants to be certain that the plume is getting smaller.

9. Are you aware of any events, incidents, or activities that have occurred at the site, such as dumping, vandalism, trespassing, or emergency response from local authorities? **Response:** No. Access is limited, largely by airport security.
10. Do you have any comments, suggestions, or recommendations regarding the site? **Response:** Treatment is working as well as expected. Subunit A extraction is limited due to chromium concentrations. The amount of contamination being removed has decreased in recent years.

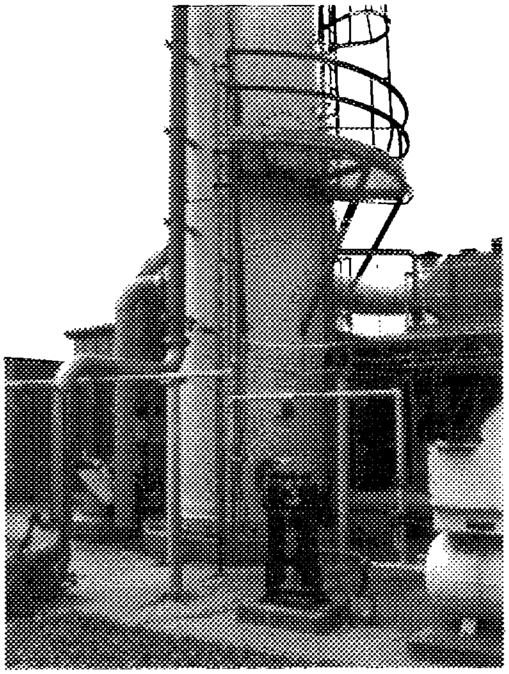
Appendix C
Site Inspection Photographs



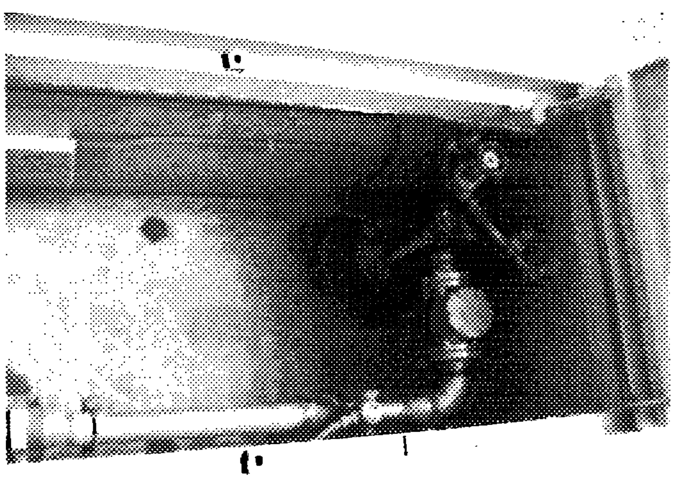
Photograph 1. Inlet piping at Subunit A Treatment System.



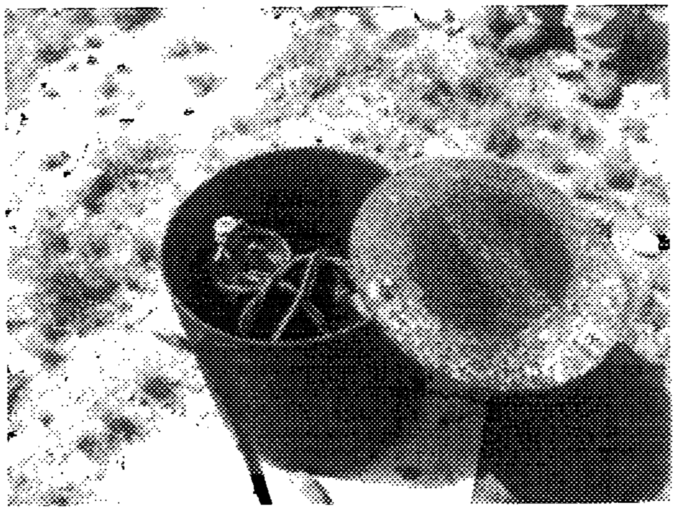
Photograph 2. Acid tank and piping at Subunit A Treatment System.



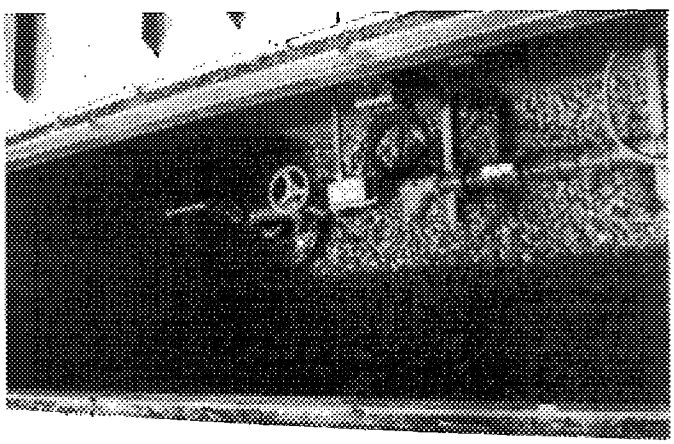
Photograph 3. Air stripping tower, Subunit A Treatment System.



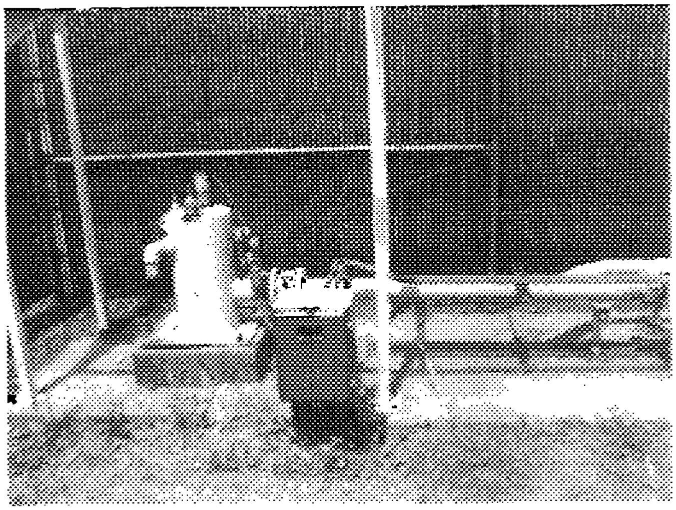
Photograph 4. Extraction Well NE-1.



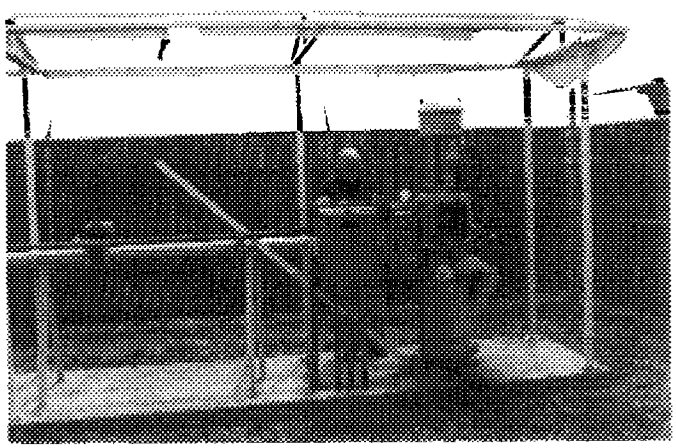
Photograph 5. Monitoring Well EMW-13.



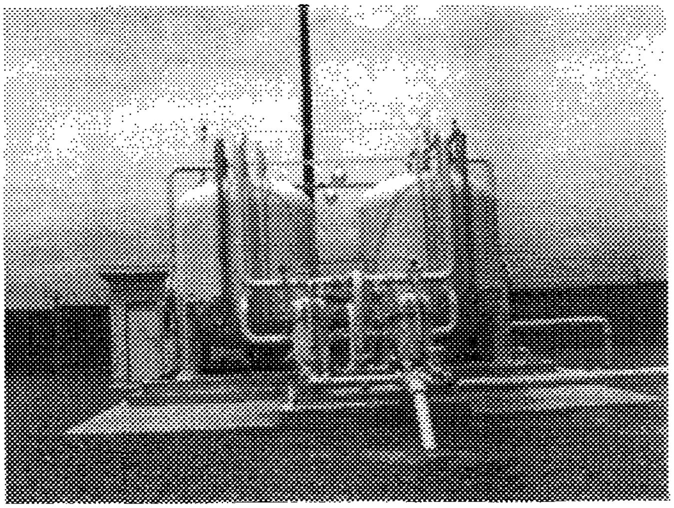
Photograph 6. Injection Well I-16 (Subunit A).



Photograph 7. Injection Well I-202 (Southern Subunit C).



Photograph 8. Extraction Well E-201 (Southern Subunit C).



Photograph 9. Southern Subunit C GAC Treatment System.

Photograph 10. Extraction Well E-102 (Northern Subunit C).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

MEMORANDUM

SUBJECT: Approval for Final Five-Year Review Report for Phoenix-Goodyear Airport South, Superfund Site, Goodyear, Arizona

FROM: Mary T. Aycock, Remedial Project Manger M.T. Aycock
Michael Montgomery, Chief
Private Sites Section (SFD-8-2)

TO: Kathleen Johnson, Chief
Federal Facilities and Site Cleanup Branch (SFD-8)

I. INTRODUCTION

A five-year review of the Phoenix-Goodyear Airport (South) Superfund Site (PGAS) in Goodyear, Maricopa County, Arizona was completed in September 2005. The purpose of the five-year review was to evaluate whether the remedial action objectives described in the 1987 and 1989 Records of Decision (RODs) remain protective of human health and the environment. The triggering action for this review was the initiation of remedial activities in 1990.

II FIVE-YEAR REVIEW SUMMARY

In 1983, the site was placed on EPA's National Priorities List (Superfund List) as the Litchfield Airport Area Superfund Site. After the airport property was transferred to the City of Phoenix, the site was renamed the Phoenix-Goodyear Airport Area Superfund site. Later, the site was divided into the Phoenix-Goodyear Airport North (PGAN) and PGAS sites due to different contamination sources and different potentially responsible parties (PRPs). The PGAS site (only) was the subject of the five-year review.

For PGAS, the 1987 ROD for Section 16 Operable Unit 2 (OU2) prescribed a remedy that addressed volatile organic compounds (VOCs), specifically trichloroethylene (TCE), in Subunit A groundwater. The objective of the remedy included containment of the VOC-contaminated plume and treatment of groundwater to selected levels using groundwater extraction and air-stripping. Construction of the groundwater treatment system was completed and operation commenced in 1990.

Current remedial system operations for Subunit A groundwater include pumping from 12 extraction wells to a vertical air stripping column containing a packing medium (to increase surface area), through which a countercurrent flow of air is introduced. Treated groundwater effluent from the system is reinjected into the aquifer.

The 1989 ROD addressed VOCs in Subunit B/C groundwater (OU6) and VOCs in soils (OU1). The remedy for VOCs in Subunit B/C groundwater was to contain the plume using four extraction wells. In 1994, three extraction wells were connected to an air stripping unit, as described above, and one extraction well, that was considered too remote to pipe into the unit, was treated with a reverse osmosis system. The remedy for VOCs in soils was to use a soil vapor extraction system (SVE) to remove VOCs from the soil.

Current remedial action operations for Subunit B/C groundwater include three extraction wells piped to a Granular Activated Carbon (GAC) treatment system. Treated groundwater is reinjected into the aquifer. For soils, extraction of VOCs using SVE has met the requirements of the remedy and was discontinued in 1998.

Chromium and cadmium were also identified in soil at PGAS. These contaminants were addressed in an Action Memorandum issued by EPA in 1991. The remedy was to remove soil containing these metals above regulatory levels and stabilize the soil using cement. This remedial action was completed in January 1993.

Despite meeting the ROD effluent goals, there are some issues related to the effectiveness of the remedy. The primary issues include: 1) the removal of TCE from Subunit A groundwater has not been optimized due to the presence of chromium, and; 2) some additional sampling of groundwater for metals may be required to confirm effectiveness of remedial actions. Other issues identified during the five-year review process relate to the possible presence of trace metals in soil and groundwater, and maintenance of treatment systems. Newly identified issues which were not previously addressed include the possibility of intrusion of VOC-contaminated vapor into industrial buildings at the site, a lack of comprehensive institutional controls, limited information on risk to ecological receptors, and encroaching contaminants such as VOCs from the Western Avenue WQARF site. Recommendations have been made and these issues are to be addressed during the remainder of 2005 and into 2006.

III. CONCLUSION

The remedies at PGAS currently protect human health and the environment because exposure pathways that could result in unacceptable risks to human health and the environment are being controlled. However, in order for the remedy to be protective of human health and the environment in the long-term, institutional controls may need to be put into place, and issues identified in the report will need to be addressed.

To insure the remedy continues to be protective of human health and the environment and is not compromised in any way, another review will be conducted within 5 years of the completion of this Five-Year Review and is scheduled to be completed by September 30, 2010.

By signature below, I concur with the conclusions and recommendations of this Five-Year Review.

Approved by: Kathleen Johnson   Date: Sept 30, 2005

Kathleen Johnson, Chief
Federal Facilities and Site Cleanup Branch

Attachment: Final Five-Year Review Report for Phoenix-Goodyear Airport South, Superfund Site, Goodyear, Arizona

Routing Checklist

Five Year Review

Site Name Phoenix - Goodyear South

CONCUR BELOW (initial and date)	Memo to Branch Chief and Five Year Review Letter	Briefing for Superfund BC (If Needed) (Note 1)	ROD or Amendment or ESD required? (Note 2)	CERCLIS Report (Note 3)	Communication Strategy (Note 4)	Weekly Report Item
Superfund RPM	sign memo		x N/A	x MTA M. Taylor	x N/A	x MTA M. Taylor
Technical Support Section Chief	c Cynthia Wetmore for HB	x CW	c CW			
Superfund Section Chief	c [illegible]	x [illegible]	c [illegible]	x [illegible]		x [illegible]
ORC Attorney	c BD		c BD			
Superfund Branch Chief	sign letter					

Notes:

The RPM initiates the checklist.
Memo to Branch Chief should outline issues/concerns if any.
Approval letter should be on EPA letterhead.
The 5 year review and companion documents generally should be part of the approval package.

'X' means that the person is responsible or participates in the listed activity.
'C' means that the person needs to concur with the decision.

A copy of this checklist should serve as the routing and concurrence page.

Note 1 : Done in consultation with both the Tech Support and Superfund Section Chiefs.

Note 2 : Concurrence needed for approval of a recommendation for a ROD amendment or ESD in the five year review.

Note 3: CERCLIS should be updated with the Five Year Review comments.

Note 4 : Communication Strategy should be considered if substantial environmental or political issues.

August 2005